International Marine Engineering

OCTOBER, 1907.

THE NEW CUNARD STEAMER LUSITANIA.

This mammoth vessel, which we have described in some detail at various times, has now made her maiden trip across the Atlantic, having left Liverpool on September 7 and arrived in New York September 13. The time between Queenstown and Sandy Hook Lightship was 5 days, 00 hours and 54 minutes. The total distance covered between these two points was 2,782 nautical miles, and the average speed was 23.01 knots. The days' runs were respectively: 561, 575, 570, 593, and 483. It will be seen that the highest days' run, 593 nautical miles, accounted for a speed of 24.71 knots.

A VIEW IN THE MAGNIFICENT FIRST CABIN LOUNGE AND MUSIC ROOM.

Through the courtesy of the Cunard Steamship Company, we are enabled to present a number of photographs of both the accommodation of this splendid vessel, and certain machinery details. We have already given the main particulars of the ship, but will recapitulate here the most prominent features. She was launched June 7, 1906, from the yard of John Brown & Company, Limited, Clydebank, her launching weight having been upwards of 16,000 tons. The length is given as 785 feet over all, or 760 feet between perpendiculars; the breadth is 88 feet; and the depth 60 feet 6 inches; the gross tonnage is 32,500; while the displacement at a draft of 33 feet is about 38,000 tons, and at 37½ feet it is 45,000 tons.

Propulsion is by means of four screws operated at a speed of 185 revolutions per minute by Parsons steam turbines of a combined shaft horsepower of about 68,000. The propellers are three-bladed, and are constructed of manganese bronze. Each of the outer or wing propellers is driven by a high-pressure turbine, while the inner shafts are rotated by low-pressure turbines. Steam is provided by twenty-five Scotch boilers, of which twenty-three, with eight furnaces each, are double-ended, and two, with four furnaces each, are single-ended. This makes a total of 192 furnaces. The boilers are divided into four groups in four separate stokeholds, and exhaust the products of combustion into four elliptical funnels with a major inside diameter of 24 feet.

The height of these funnels above the keel is 154 feet. The coal capacity of the bunkers is 7,000 tons, and it is estimated that nearly 6,000 tons will be required on each trip across the Atlantic.

Accommodation is provided for 552 first class passengers in 258 state rooms; 460 second class passengers in 145 state rooms; and 1,200 third class passengers. We can but glance at the main features of the principal public rooms, of which we present two or three illustrations.

The first class dining saloon is distributed over parts of two decks, the upper section being arranged around the opening under the mammoth dome; it is thus on a sort of mezzanine floor. Provision is made for seating 462 at one time, of whom 143 are in the upper room. The lower saloon, on the upper deck, is 86 feet long and extends the full width of the ship, which makes it practically square; the upper section is about 63 feet in each dimension. The decorations of both are in the Louis XVI style, with white walls and gilded frieze. The dome has a height of 30 feet, and is elliptical in plan. All the carving on the walls and pillars is of solid wood, the carving being by John Crawford, of Glasgow, and the gilding and other decorations by Waring & Gillow, Limited, of London. The dining saloon for children, seating 36, is in connection with the nursery, on the shelter deck. This is in the same style as the main dining saloon, but is much simpler.

The first class smoking room is on the boat deck at the after end of the ship, and measures 50 by 55 feet. The walls are paneled with Italian walnut, special advantage having been taken of the grain and figure of the wood. The idea is borrowed from the eighteenth century. The furniture has been fitted by Marsh, Jones & Cribb of Leeds, and is of Queen Anne pattern. The general tone is Italian red. One of the most striking features of the room is the fireplace, located between two fluted pillars, and surmounted by an ornamental panel. Aft of this room is a "veranda café," open at the rear.

The first class lounge, which measures 52 by 68 feet, is located on the boat deck just aft of the entrance hall. The decoration is in Georgian style, with mahogany paneling inlaid with specially selected and finely figured woods. The furniture is of mahogany, and consists largely of settees and large easy chairs, as well as groups of chairs around small tables. The general color scheme is green, carpets, upholstery, cushions and curtains being of this color. At each end of the room are large marble fireplaces, set off by columns of Mexican onyx. Over the fireplaces are enameled panels from Alexander Fisher, of London. The ceiling is dome-shaped, with a height of 20 feet, and with figured skylights in the dome in twelve panes, furnished by Oscar Paterson, of Glasgow, and representing, each, one month of the year.

THE MAIN DINING ROOM HAS AN UPPER STORY, JUST VISIBLE UP THROUGH THE OPENING AT RIGHT.

The first class writing room and library measures 44 by 52 feet and is situated on the boat deck, forward of the grand entrance hall. The decoration is in Adams style of the latter part of the eighteenth century, the walls being paneled with pilasters and moldings, the panels being in delicate gray and cream silk brocade. The windows, which, in common with the lounge and smoking room, are extremely large, are set off by curtains copied from an old document found in Milton Abbey. The color of the carpet is rose, while the furniture, fitted by George Trollope & Sons, of London, is upholstered in the same colors. This furniture is of inlaid mahogany, each writing table having a finely chased and mercury gilt lamp. A circular skylight of leaded

THE QUADRUPLE SCREW TURBINE-PROPELLED CUNARD LINER LUSITANIA RUNNING AT ABOUT 25 KNOTS ON HER TRIAL TRIP.

glass, with electric lights around the base, is surrounded by a decorative treatment in the ceiling, which includes a number of tasteful electroliers.

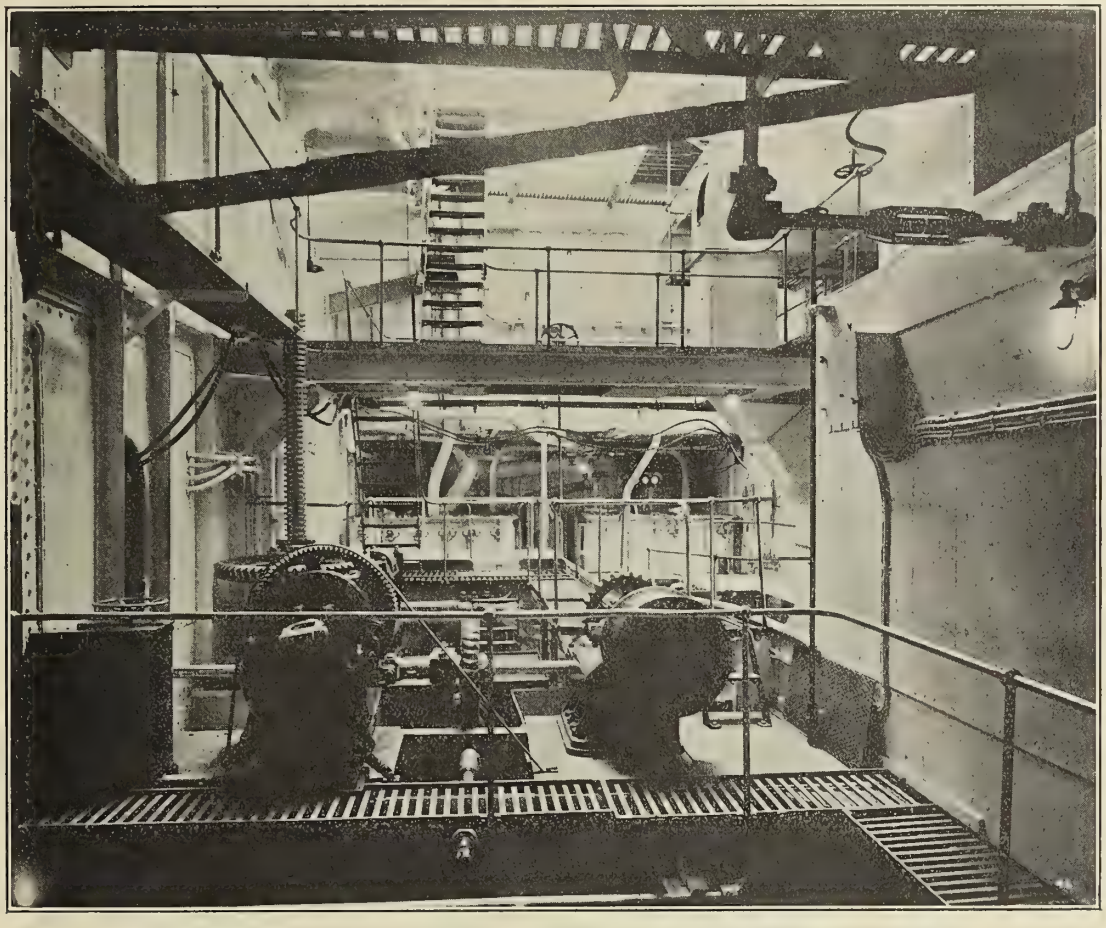
The grand entrance and stairway extend altogether from the first class entrance on the main deck through the upper, shelter, promenade and boat decks, to a total height of 44 feet. On each of these decks, except the saloon, the hall extends the full breadth of the vessel, or deckhouse, as the case may be, and measures 24 feet in the fore-and-aft direction. Throughout these decks of the vessel are worked two electric passenger elevators, situated in the well of the stairway. The gates and surrounding frames of these elevators are of black and gold metal work, contrasting well with the simple white treatment of the hallways. On the promenade deck, one side of the hallway is taken up by the bureau of information; while the purser and doctor have quarters flanking the grand entrance on the shelter deck.

Besides the large number of staterooms for first and second class passengers, which differ little from similar rooms in other ships, there are a total of eighty-seven special cabins or suites, located mainly on the promenade deck. These suites have been furnished and decorated by Waring & Gillow and George Trollope & Sons, of London, and Wylie & Lochhead, of Glasgow. There are two regal suites, comprising each a drawing room, dining room, two bedrooms, bath room and pantry. In addition to these are a large number of suites of two rooms each with bath, and arranged so that one room may be used as parlor and the other as bedroom, or, if necessary, both may be used for sleeping. The regal suites are both in the Louis XVI style, many of the details of that on the port side being based upon the Petit Trianon of Versailles. In this case the dining room is paneled with fine Italian walnut, with carved ornaments and moldings of burnished gold, with the buffet, writing table, dining table and revolving chairs in Italian walnut and gold. This room has a chimney piece of Fleur-de-Pêcher marble, with a log fire. The drawing room of this suite is paneled in white, the curtains being heliotrope and cream, with green settees and carpet and mahogany writing table. The bedrooms are respectively of rose colored silk panels with satinwood furniture inlaid with green, and white and gold relieved by Wedgwood cameos. In the other case the dining room is of paneled mahogany with inlaid mahogany furniture, and the drawing room of sycamore with satinwood furniture. Others of the special suites are decorated in various styles, including English and Colonial Adam, Georgian, William and Mary, Sheraton, Louis XV, Louis XVI and Empire, no two being quite alike.

The second class accommodation includes drawing room, smoking room, dining room and lounge, splendidly designed, the latter measuring 40 by 42 feet, and surmounted by a skylight over the staircase. This lounge is fitted out in mahogany, and arranged with easy chairs and settees and small tables. The drawing room measures 28 by 42 feet, and is gray in tone, being of the Louis XVI style. The furniture is of satinwood, and includes writing tables and book cases, so that it serves the double purpose of drawing room and of library and writing room; the carpet and curtains are rose color. The smoking room is on this same (promenade) deck, and measures 33 by 52 feet. It is Georgian in design, with a white ceiling and plaster dome. The paneling and furniture are of mahogany. Small square tables and comfortable upholstered chairs are fitted. The dining saloon is also in Georgian style, and measures 60 feet fore-and-aft, stretching clear across the ship. The panels and pillars are delicately carved in white, while a circular well overhead is surrounded by a carved pilaster. A mahogany sideboard is placed at the forward end.

THE PRIVATE DINING ROOM IN ONE OF THE TWO SUMPTUOUS REGAL SUITES.

The third class passengers are located in the forward end of the vessel, from the lower to the forecastle deck, being accommodated in cabins of two, four, six and eight berths each. The dining saloon for this class measures 80 feet fore-and-aft, and covers the entire width of the vessel at this point (about 65 feet at the after end, and 45 feet forward). It is situated on the upper deck, and accommodates 350 passengers at one sitting. It is fitted out in polished pine tables with circular revolving seats, and has a piano at the forward end. The ladies' room and the

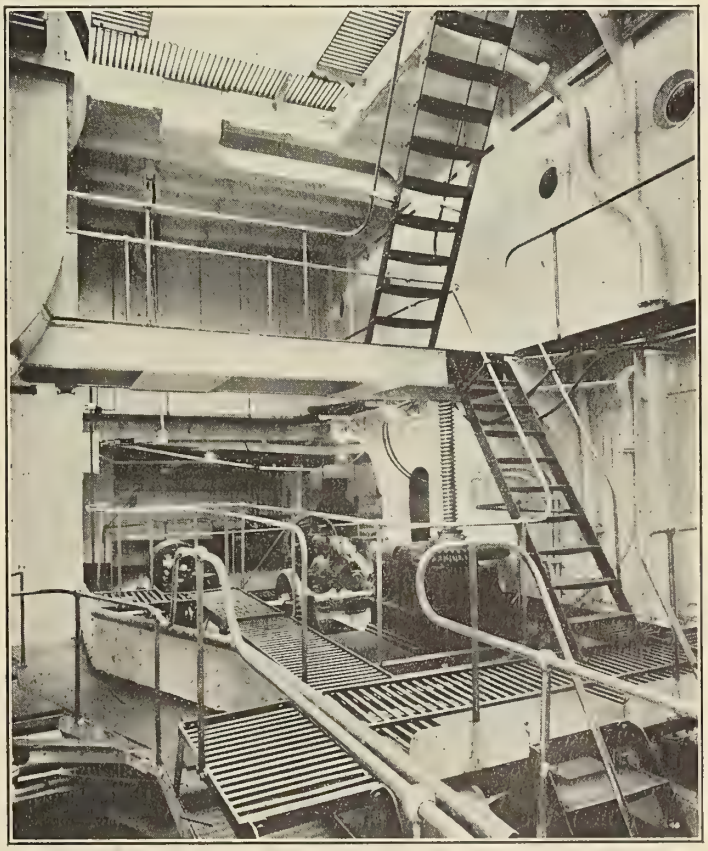


IN THE UPPER ENGINE ROOM. MACHINERY FOR LIFTING THE CASING COVERS ON MAIN TURBINES.

smoking room are located on the shelter deck, and fitted up in the same style as the dining saloon. The forecastle deck side plating has been carried aft far enough to provide shelter for the promenade space allotted to third class passengers. This space has been fitted with wide seats, and, for a length of about 150 feet on each side of the ship, affords a commodious and comfortable lounge.

The machinery was given somewhat extended description in our issue for August, 1906, a portion of which we reprint here. The main propelling turbines have rotor drums, 96 inches in diameter for high-pressure and 140 inches for low-pressure, with astern drums of 104 inches. These drums were all hollow forged, the low-pressure being, it is said, the largest hollow forgings ever made. They measure 8 feet 2 inches in length, and, as the metal is 3 inches thick, the inside diameter is 11 feet 2 inches. The turbine blades vary in length from 2¼ to 22 inches, the larger sizes requiring special strengthening for radial and lateral stiffness. This is furnished by means of three rows of shrouding, consisting of circumferential strips laced with copper wire and soldered, and provided with expansion joints formed of brass tubes, to take care of expansion and contraction due to variations in temperature. The lifting gear, which is illustrated in our photograph of the upper part of the engine room, is capable of handling the casings of the turbines. The upper half of the casing in each of the low-pressure turbines has the immense weight of 115 tons. The rotor, casing and blades of the low-pressure turbines weigh about 450 tons.

While the rotor is in one piece, the casing requires to be in two pieces, one for the lower part of the circumference and the other for the upper, both being ultimately bolted together to form a complete circle. Around the rotor, grooves were turned, into which the actuating blades were secured; and on the inner surface of the casing similar grooves were formed for the fixed



VIEW OF THE TOP PLATFORM IN THE ENGINE ROOM.

blades, to guide the steam against the moving blades on the rotor. There is only about one-twentieth part of an inch between the tips of the rotating blades and the surface of the casing, and a similar clearance between the fixed blades on the casing and the surface of the rotor. The speed at the periphery of the circle formed by the blades on the rotor ranges from 100 to 150 feet per second (68 to 102 miles per hour), so there must be no possible contact between the moving blades and the adjoining surface, yet there must be a minimum space between the blades and the neighboring surfaces, otherwise steam would escape and be wasted.

The blades of the turbines are of brass. Their length increases from the point where the steam from the boiler enters, to the last row, where the steam passes to the condenser. The steam expands continually, and at each row of blades there is a presumed drop in pressure equal to about one pound per square inch. Each successive row of blades should be larger than that immediately preceding, but it is found in practice feasible to make five or six rows of the same length. In large turbines such as these, there are nine groups, which successively are of blades of increased length. With fast-running turbines used for driving electric dynamos the blades are very small; but in the *Lusitania*, for the large propellers and running them at low speed, it is necessary to minimize the number of revolutions. Therefore the turbine blades have been fixed at over 20 inches at the low-pressure end of the low-pressure turbine.

The blades of brass were wedged into the grooves formed on the rotor and casing, at right angles to the surface, and in each ring are equi-distant from each other, but, to accommodate expansion, the distance between rings increases with their length, so that near the condenser the interval separating the rings attains its greatest width. The blades are bound together by a brass wire tape, which fits into square indents made on the back edge on each blade near the top. This wire is laced with a copper round wire, and the whole is cemented with silver solder. This binding strengthens the long blades. After the blades were put into their grooves in their rotor or casing, and finally secured and bound together, the complete unit was put into a lathe in the case of the rotor, or a boring machine for the casing, to insure that there should not be a greater deviation in length than about the one-thousandth part of an inch, equal length being essential in view of the small clearance between the blades and the surface past which they rotate. The blades are also in perfect alinement, necessitated by the small distance between the edges of the fixed and moving blades. In the larger blades there is a length of edge of over twenty inches working at a great speed past a corresponding length of fixed blades, and the slightest tendency to rubbing would be disastrous.

A VIEW IN THE STOKEHOLD OF THE LUSITANIA, SHOWING SCOTCH BOILERS.

A gland packing was devised on a plan to prevent the escape of steam at the end of the turbines, and a system has been perfected for taking up the expansion. The longitudinal adjusting of the rotor within the casing also determines the distance between the edges of the moving and fixed blades. Mr. Parsons devised a system consisting of a "finger plate" secured to the fixed frame of the turbine, which indicates on the rotor shaft the exact clearance permissible, so that the engineer can tell at a glance whether the rotor is in its exact position in relation to the fixed blades in the casing. Screws are provided so that adjustments can be made in the relative position longitudinally of the rotor and casing.

To keep the rotor in a true level in its bearings, and record any tendency to sag, a vertical point is fitted at the end of the casing immediately over the shaft, and by this any change in level of the rotor or shaft, even the thousandth part of an inch, can be detected.

The greater the vacuum the higher the efficiency of the tur-

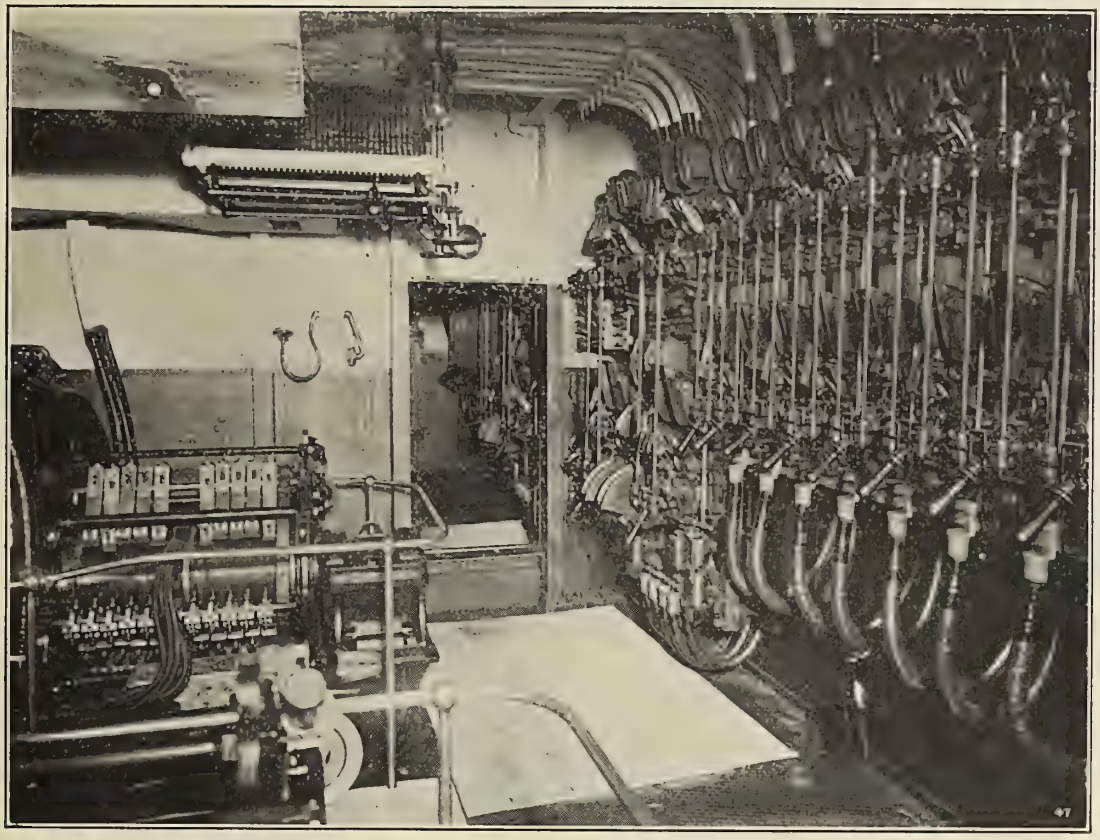
bine; but as the head of steam and its driving action are opposed to the forward thrust of the propellers, there is not the same need as with ordinary reciprocating engines for a thrust block to transmit the thrust of the propeller to the ship. In the case of each turbine on the *Lusitania* there is a thrust block for use in starting the machinery, and in changing "ahead" to "astern" motion. In the case of the reversing turbines, the blades are similar to those in the "ahead" turbines, but are mounted with the curve so arranged that the flow of the steam against the concave surface will rotate the shafts and propellers in the stern direction.

The double-ended boilers are 17 feet 6 inches in mean diameter, with a total length of 22 feet. Each boiler has 344 stay tubes and 720 plain tubes, the total number being 1,064. The total heating surface of one boiler is 6,593 square feet, with a grate area of 169 square feet. Each furnace has a separate combustion chamber. The total grate area of all the boilers is 4,048 square feet, while the aggregate heating surface is 158,350 square feet. The ratio between these two is 39.1 to 1. The working pressure is 195 pounds per square inch. The (Morison corrugated) furnaces have an inside diameter of 45 inches and a maximum diameter of 49½ inches, with a thickness of $\frac{31}{32}$ inch. They were made in the Atlas Works, Sheffield, of John Brown & Company, Limited. The length of tubes between tube sheets is 7 feet 10½ inches. The combustion chambers are stayed on top by the ordinary bridge girders. The shells are of high tensile steel with a maximum tensile strength of 79,000 pounds per square inch. The boiler heads are, as usual, of mild steel. The elliptical funnels have a height above the grate of 130 feet, and the outer casing has extreme axes of 19 and 26 feet.

It may be of interest to remark that the aggregate area of grates is larger than that of two city lots, each 20 by 100 feet. The heating surface, 3.64 acres, is very near that of a New York city block, 200 by 800 feet. The total length of each of the 25,536 boiler tubes is 8 feet 0⅜ inch. If placed end to end, they would extend for a distance of 205,086 feet, or 38.85 statute miles. Fast as the steamship is, it would take her an hour and twenty minutes to cover this distance, which is 261 times her own overall length.

Forced draft on the Howden system of heated air and closed ash pits is furnished by thirty-two fans in pairs, driven by sixteen electric motors. The impellers are 66 inches in diameter, and at 450 revolutions per minute produce an air pressure equivalent to 3½ inches of water. The motors are of 50 horsepower and 100 volts.

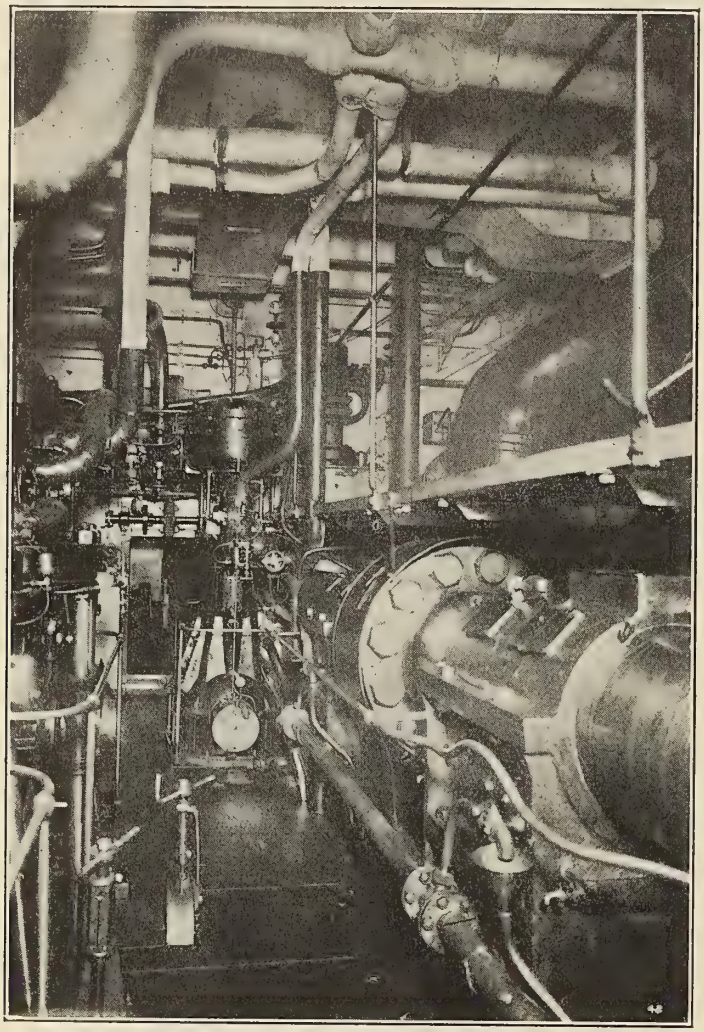
There are four main condensers arranged in pairs, with an aggregate cooling surface of 82,800 square feet (1.9 acres). In addition, there are two auxiliary condensers of 2,000 square feet each, with separate circulating and air pumps. The main circulating pumps were furnished by W. H. Allen, Son & Company, Ltd., Bedford, and consist of eight centrifugal pumps arranged in four pairs, with suction and discharge pipes 22 inches in diameter. Each pair is driven by a simple high-speed engine, 18 inches in diameter with a stroke of 10 inches, and capable of developing 350 horsepower at a speed of 300 revolutions per minute.



THE SWITCHBOARD AND AN END OF ONE OF THE TURBO-GENERATORS FOR LIGHTING.

The four main air pumps were furnished by G. & J. Weir, Ltd., Glasgow, and are 40 inches diameter by 24 inches stroke, with each two steam cylinders and two pump barrels. In addition to these wet air pumps are fitted four double dry air pumps, 24 inches diameter by 7 inches stroke, for taking care of unexpected or accidental leakage. From the hot well, the feed water is taken by four Weir pumps, 14½ by 30 inches, and passed through two surface feed heaters, where the exhaust steam from all auxiliaries except the turbo-generators is employed to heat the feed water for the boilers. There are also two direct connected heaters into which the exhaust from the turbo-generators is led.

The arrangement of the machinery is somewhat unusual. The high-pressure turbines proper are forward of the low-pressure turbines, and are, of course, in the wings instead of near the center line of the ship. The astern turbines are located a little



THE PUMP ROOM IN THE SHAFT TUNNEL.

further forward than are the high-pressure turbines, and are connected to the center shafts. The main condensers are located, two on each side of the center line, in a separate room entirely aft of the low-pressure turbines, and receive exhaust steam from two immense pipes passing through a watertight bulkhead. Directly beneath these condensers are the hot well tanks, not in the double bottom, but located above the ballast tank. Back of another watertight bulkhead are grouped, in each of two watertight compartments, the main circulating pumps, the main air pumps and the dry air pumps, one double set for each pair of condensers. In the wings outboard from the low-pressure turbines are the evaporators, in two separate compartments. The auxiliary condensers and the bilge pumps are located in the forward end of the engine room. The surface feed heaters are above the load waterline, and directly above the astern turbines.

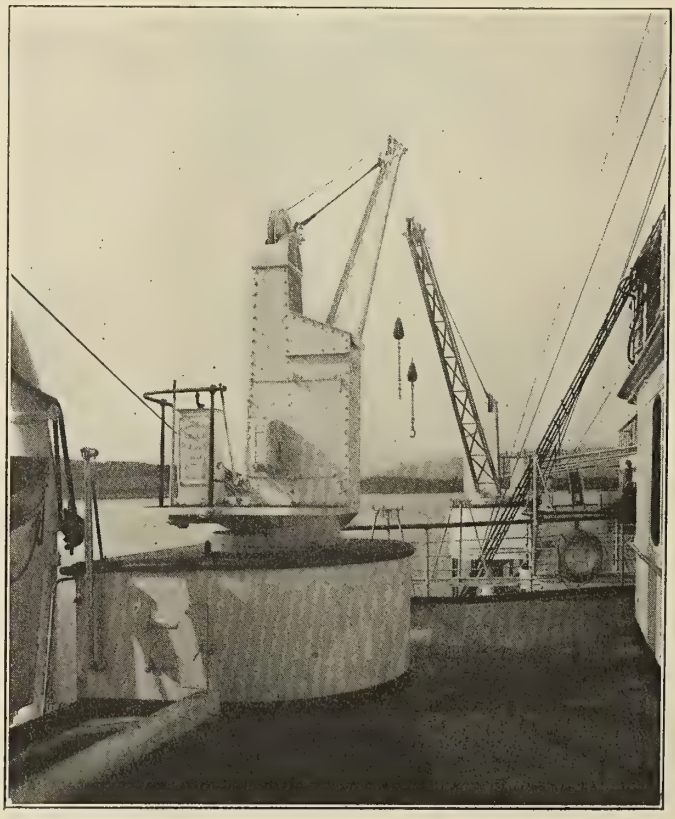
The ventilation of the engine room is accomplished by means of eighteen electric fans furnished by Laurence, Scott & Company, Ltd., of Norwich, in sizes 35, 30 and 25 inches diameter. The output of free air for the largest is 26,000 cubic feet at 315 revolutions per minute, and for the smallest, 14,000 cubic feet at 450 revolutions. The fans themselves are of the Sirocco type, made by Davidson & Company, of Belfast. Ventilation of the ship as a whole is by the Thermo-Tank Ventilating Company of Glasgow. Each unit of the apparatus consists of an electric motor operating a Sirocco fan which discharges air into a tube heater, and thence to the main distributing tanks. In this way the temperature of the air delivered can be regulated as required. The outfit on this ship is designed to change the air in the various compartments from six to eight times per hour, and to maintain a temperature of at least 65 degrees F. in the coldest weather.

Electric lighting is furnished by means of four duplicate turbo-generators, furnished by C. A. Parsons & Company, Ltd., Newcastle-on-Tyne, and located in a compartment above the air pumps. Each unit measures 23 feet 11 inches over all, and has an output of 375 kilowatts at a voltage of from 110 to 120. The rate of rotation is 1,200 turns per minute. Each dynamo is shunt wound, the armature being of the surface drum wound type, with one turn per section. Tests of these units have shown a steam consumption at full load of from 46 to 48 pounds per kilowatt hour. The consumption rises to above 60 pounds at half load.

Two independent refrigerating installations, furnished by the Liverpool Refrigeration Company, Limited, have been fitted, one to take care of the provisions of the ship, while the other set looks after perishable cargo. The former is located on the main deck near the forward end of the engine room, the cold chambers being on the lower deck on each side, a little further forward, and above the after boiler room. Insulation is of granulated cork in combination with moisture proof paper and white pine boards. The capacity is about 13,000 cubic feet. The installation is on the carbonic-anhydride principle, and consists of a horizontal compound duplex machine with vertical evaporator and two horizontal duplex brine pumps. The cargo refrigeration plant is forward on the starboard side of the shelter deck, and is connected with an extensive range of cold chambers on the orlop decks, insulated as before.

Steam steering has been supplied by Brown Brothers & Company, Limited, Edinburgh, and is actuated by a two-cylinder horizontal engine with cylinders 14 inches in diameter by 14 inches stroke. Another similar engine is held in reserve, for emergency use. The maximum angle of displacement of the rudder head is 35 degrees in each direction. Each set of engines is capable of exerting a torsional strain on the rudder stock of 1,240 foot-tons, with a steam pressure of 150 pounds and a back pressure of 20 pounds. The main steering engine is mounted on the forward end of the false tiller, with steam and exhaust pipes arranged in the axis of rotation.

The subdivision of the ship into watertight compartments is



BAGGAGE-HANDLING CRANES ON THE BOAT DECK.

arranged to permit of ready communication between the different sections, by means of a series of horizontal and vertical sliding watertight doors on the Stone-Lloyd system, constructed by J. Stone & Company, Limited, of Deptford. These are actuated by hydraulic power supplied by a pressure main running nearly the entire length of the vessel. The doors may be operated either from their immediate positions, or from the bridge, and in the latter case either singly or *en masse*. On the bridge is an electric indicator, in which lights inform the officer in charge as to the state of each door.

One of our photographs shows a novelty fitted on this ship in the shape of electric cranes built by Stothert & Pitt, Limited, Engineers, Bath. There are four of these cranes fitted, two on each side, all having a capacity of 30 cwt. One on each side works at a radius of 18 feet, and the other at 25 feet. The lifting motor gives 15 horsepower at 500 revolutions and 110 volts, and raises the full load at a speed of 100 feet per minute. The slewing motor is of 2½ horsepower at 750 revolutions, and is capable of slewing the crane at such a rate as to give a speed of 400 feet per minute at the limit of reach. In addition to these cranes, there are four electrically operated boat hoisting winches manufactured by Laurence, Scott & Company, Ltd., Norwich.

The amount of space taken up by machinery is interesting. The total machinery outfit extends from frame 233 forward to frame 50 aft, a distance of 482 feet 2 inches. To this must be added 29 feet 6 inches for the cross bunker extending from frame 233 to 245, making 511 feet 8 inches in all. This space is divided as follows: the forward boiler room, containing five double-ended and two single-ended boilers, 96 feet; three other boiler rooms, each containing six double-ended boilers, 80 feet each; making a total of 336 feet for boilers; the low-pressure engine room, 90 feet 8 inches; condenser room, 26 feet 8 inches; air and circulating pump room, 28 feet 10 inches. The high-pressure engine room measures 61 feet 4 inches in length, and, with the evaporator room of 29 feet 4 inches, covers the space alongside the low-pressure engine room on each side of the ship. It should be noted that the entire distance of 482 feet 2 inches is taken up by machinery, there being in this space no cross bunkers whatever. The width of the boiler rooms is about 56 feet. The sides of the ship in way of the boilers are taken up by bunkers.

An extensive series of trials of the *Lusitania* included four successive runs alternately north and south over a course of 303 miles in extent. The mean speed was 25.4 knots. On these runs the boiler pressure averaged 186 pounds per square inch, the mean vacuum was 28.2 inches, the mean revolutions of the four shafts were 188 per minute, while the power as read from the torsion meter was 64,600 shaft horsepower, corresponding with probably 70,000 (indicated) horsepower. The circumferential velocity of the rotors of the low-pressure turbines was about 150 feet per second. The draft was 32 feet 9 inches, corresponding with a displacement of about 37,000 tons.

With slightly less draft, the ship made two runs over a course of fifty-nine nautical miles at an average speed of 26.45 knots, which is absolutely without parallel in any other vessel except of the torpedo boat and destroyer types, where everything is sacrificed to the one consideration of speed alone. Even the scout cruisers of the British navy have failed to attain such a speed as this, their highest record being 25.88 knots.

An International Congress of Navigation is to be held in St. Petersburg in June, 1908, and invitations have been issued to engineers all over the world for papers or other professional contributions. As regards ocean navigation the congress seeks information as to the best type of sea-going vessel for freight service, and in relation to transshipment of cargo to craft on inland waterways and canals. A subject of more definite nature is the relative advantage of dry-docks, floating docks, lifting appliances, etc., for the repair of ships. The other subjects under the general head of "Ocean Navigation" are the application and preservation of armored concrete in maritime works, harbors of refuge, the construction of ports on sandy shores, etc. As to inland navigation, three questions are being addressed to all interested in such matters. These are (1) arrangements to be given to weirs in rivers having great variations of discharge, and occasionally carrying down large quantities of ice, so as to subserve the interests of navigation and industry; (2) study of the economical and technical conditions of the working arrangements and mechanical traction of boats on rivers, canals, and lakes, and of the regulations necessary for this purpose: (3) equipment of ports of inland navigation, especially the advance made in electric plants. Papers will be read on the participation of the government and the various parties interested in the expenses necessary for the development of inland navigation, including, the power to be given to the government to acquire a part of the land which would be improved in value along new waterways.

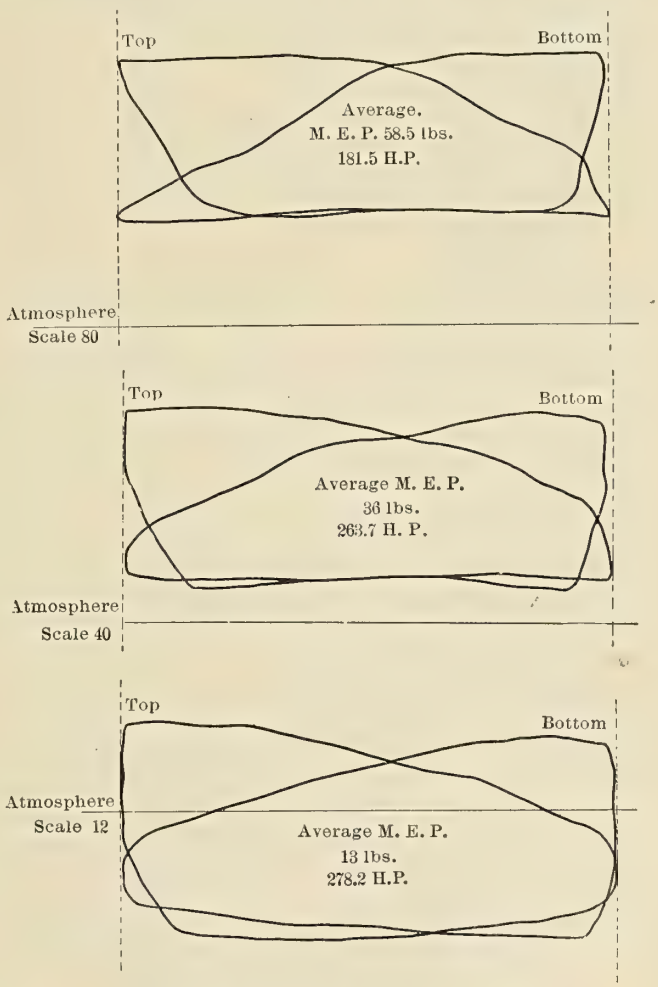
COMBINED INDICATOR CARDS.

BY CHARLES S. LINCH.

(*Concluded.*)

WINYAH.

The steamer *Winyah* was built in 1892 by the Jackson & Sharp Company, Wilmington, Del., her engine and boilers having been supplied by Neafie & Levy, of Philadelphia. She measures 200 feet between perpendiculars; 219 feet over all, with a beam of



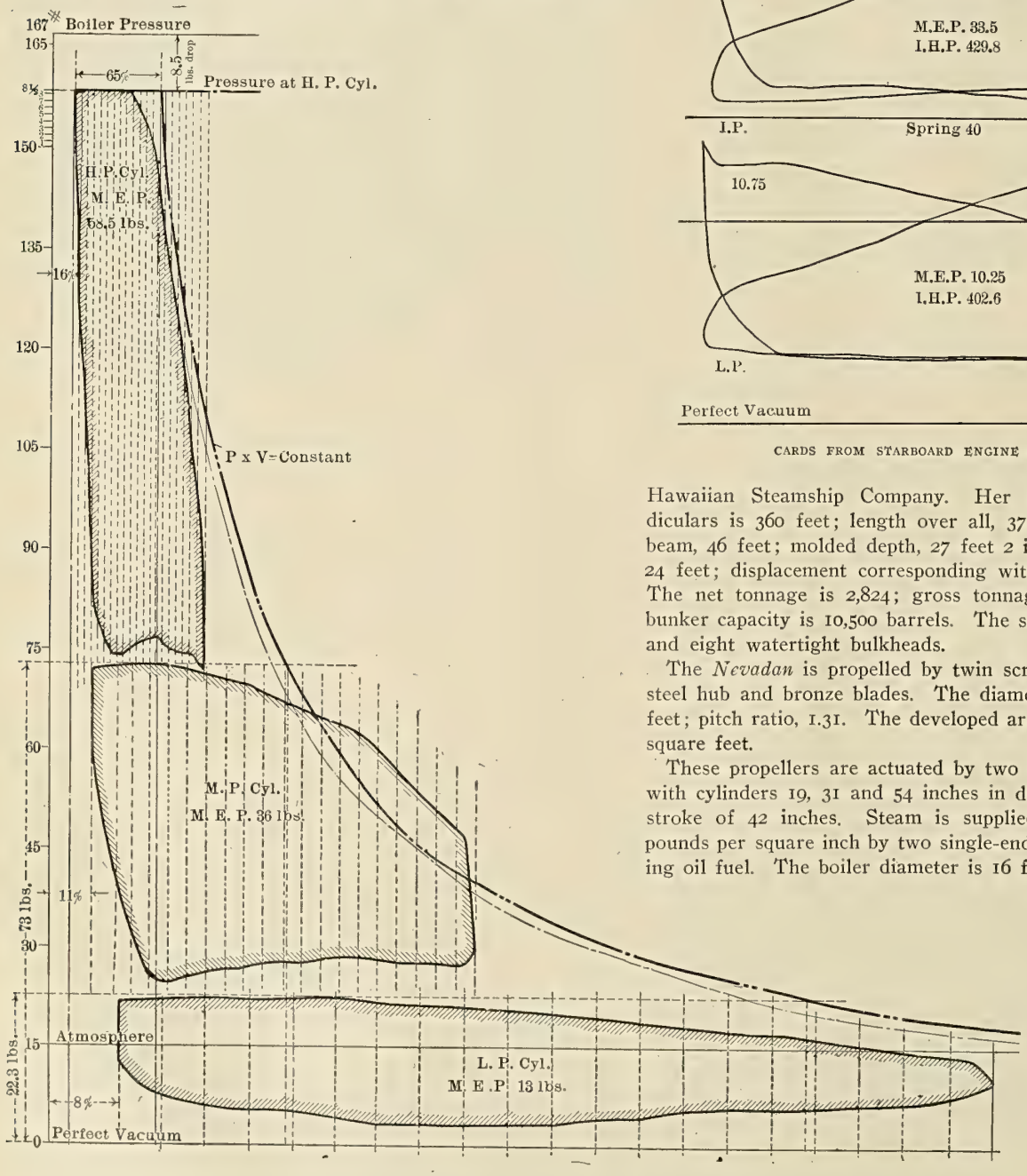
INDICATOR CARDS FROM WINYAH ENGINE.

38 feet and a depth of 26 feet 1 inch. Her net tonnage is 1,445; gross tonnage, 1,682.

A speed of 10 knots is obtained with one screw propeller having a diameter of 10 feet, a pitch ratio of 1.4, and a pitch of 14 feet. This propeller is actuated by a triple expansion engine with cylinders 16, 24 and 41 inches in diameter with a common stroke of 30 inches. Steam is supplied by two single-ended cylindrical boilers with a diameter of 10 feet 6 inches, and a length of 11 feet. The working pressure is 160 pounds gage.

The ratio of low-pressure piston displacement to high-pressure is 6.56; low-pressure to intermediate, 2.91; intermediate to high-pressure, 2.25. The apparent cutoff is 65 percent. Taking account of clearance, however, we find that the real cutoff is $\frac{81}{116} \div \frac{6.56}{0.698}$, or 69.8 percent. The total ratio of expansion is 9.39, *i.e.* ——. The initial pressure in the high-pressure cylinder is 158.5 pounds absolute. The initial pressure in the intermediate cylinder is 73 pounds; in the low-pressure cylinder, 22.3 pounds; the back pressure is 3.25 pounds per square inch. The mean effective pressure theoretically is 51.4 pounds referred to the low-pressure cylinder. The cards, however, show a mean effective pressure of only 34.31 pounds. The ratio between the two gives the card factor, which is 66.7 percent.

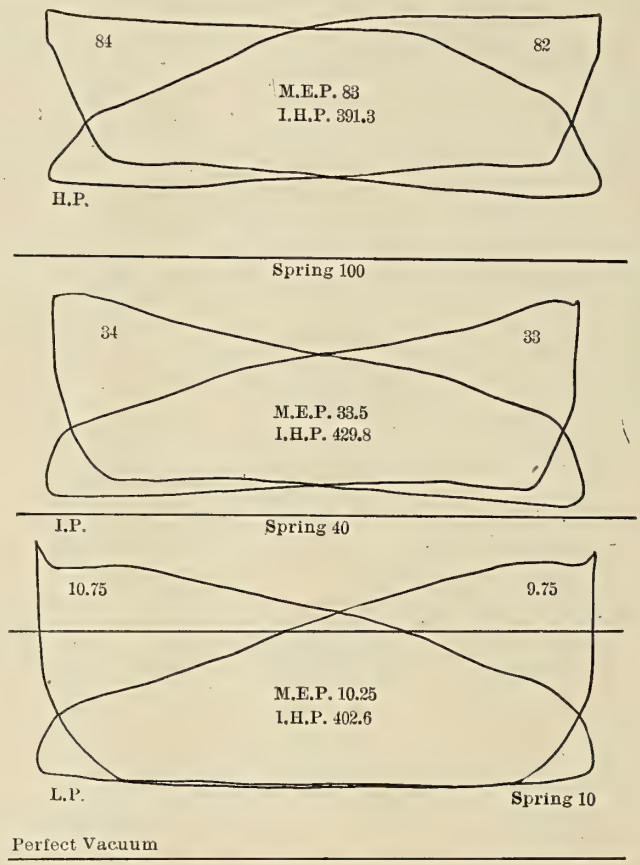
The terminal pressure due to the ratio of expansion would be 16.9 pounds. The cards, however, show a terminal pressure of only 13.7 pounds. The pressure in the first receiver was 60 pounds gage; in the second receiver, 11 pounds gage. With the throttle wide open, the revolutions were 107 per minute. The temperatures of hot well and feed water were respectively 120 and 180 degrees Fahrenheit. The engine developed a total of 723.4 indicated horsepower.



COMBINED INDICATOR CARDS FROM THE ENGINE OF THE STEAMSHIP WINYAH.

NEVADAN.

The steamship *Nevadan* was built in 1902 by the New York Shipbuilding Company, Camden, New Jersey, for the American Hawaiian Steamship Company. Her length between perpendiculars is 360 feet; length over all, 371 feet 6 inches; molded beam, 46 feet; molded depth, 27 feet 2 inches; mean load draft, 24 feet; displacement corresponding with this draft, 8,650 tons. The net tonnage is 2,824; gross tonnage, 4,408 tons. The oil bunker capacity is 10,500 barrels. The ship has a double bottom and eight watertight bulkheads.



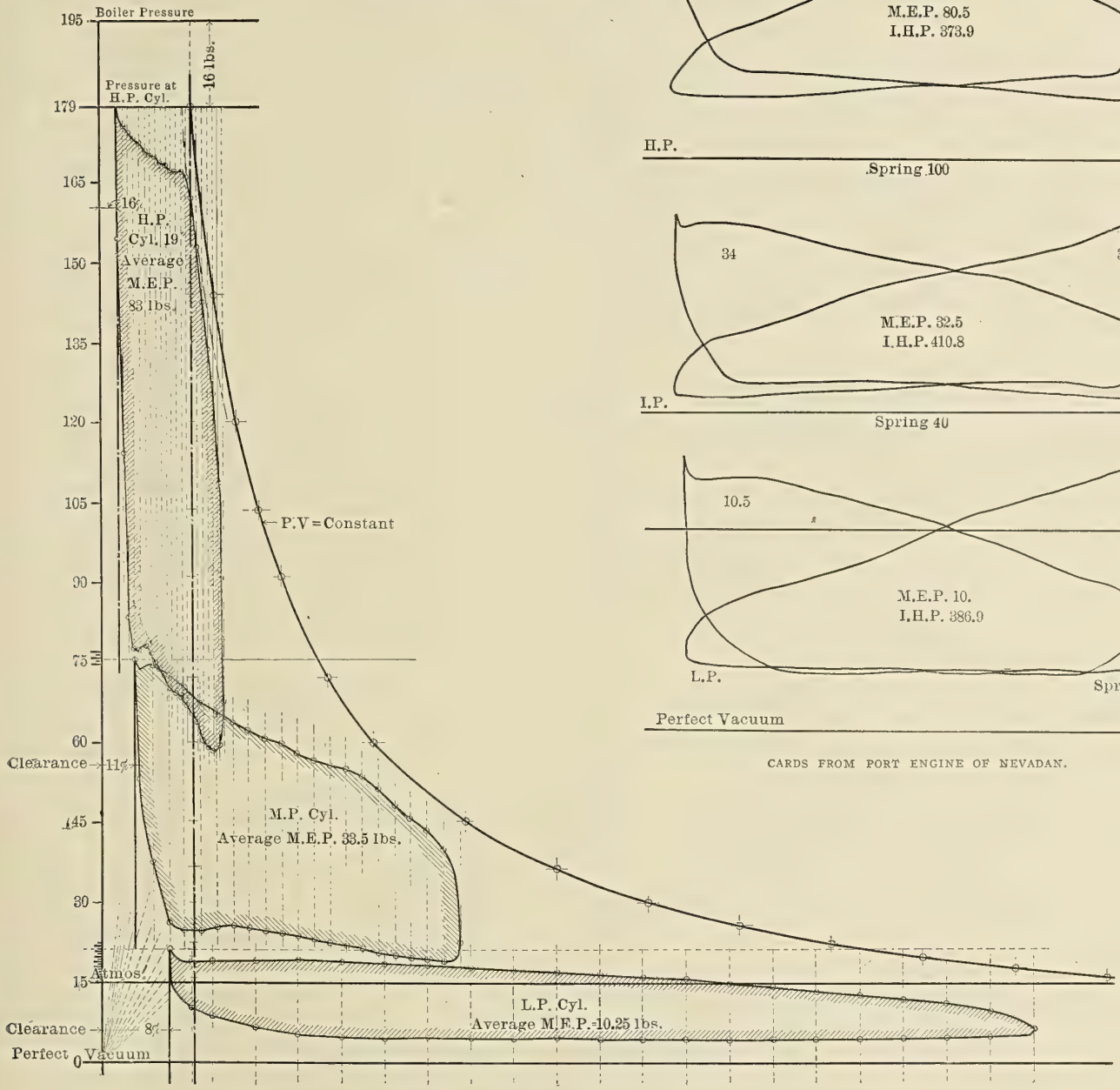
CARDS FROM STARBOARD ENGINE OF NEVADAN.

The *Nevadan* is propelled by twin screws, each having a cast steel hub and bronze blades. The diameter is 13 feet; pitch, 17 feet; pitch ratio, 1.31. The developed area of one propeller is 55 square feet.

These propellers are actuated by two triple expansion engines with cylinders 19, 31 and 54 inches in diameter, with a common stroke of 42 inches. Steam is supplied at a pressure of 200 pounds per square inch by two single-ended Scotch boilers, burning oil fuel. The boiler diameter is 16 feet 3 inches, and length,

11 feet 6 inches. Each boiler has four furnaces of an inside diameter of 41 inches; each furnace having a separate combustion chamber, and being fitted with two oil burners. Each boiler has 390 tubes, 3 inches in outside diameter and 8 feet 3 inches long between sheets. The grate surface for the two boilers is 156 square feet; total heating surface, 6,070 square feet, ratio, 38.9 to 1.

The cylinder clearances are respectively 16 percent for the high-pressure; 11 percent for the intermediate and 8 percent for the low. The ratio of low-pressure piston displacement to high-pressure is 8.07; low-pressure to intermediate, 3.03; and intermediate to high-pressure, 2.66. The total ratio of expansion is 9.96, corresponding with a theoretical terminal pressure of 17.9 pounds on an initial pressure of 179 pounds absolute in the high-pressure cylinder. The back pressure is 4.5 pounds. The mean effective pressure theoretically is 54.6 pounds. Figured from the cards the mean effective pressure referred to the low-pressure cylinder is 31.58 pounds per square inch. The card factor, or ratio between these two, is 57.9 percent. The starboard engine developed 1,223.7 indicated horsepower; port engine, 1,171.6; total, 2,395.3 horsepower.

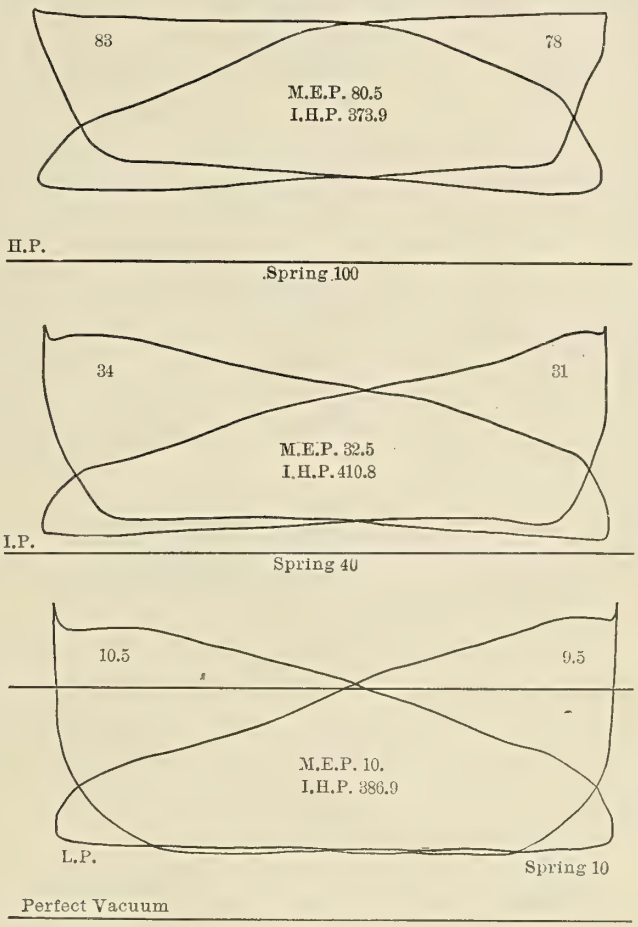


COMBINED CARDS FROM ENGINES OF THE STEAMSHIP NEVADAN—MEAN OF THE TWO ENGINES.

GENERAL.

In reference to the *Mohican*, it has been through the effort and hard constant work of her chief and first assistant that the engine is the beautiful working machine it is to-day. The cards shown are from one of four runs; two were taken in Delaware Bay, the other two were taken between Winter Quarter and the Tail of the Shoe lightships. The combined cards are a mean of the four sets. The actual coal consumption is 18 tons.

The cards of *Winyah* and *Nevadan* show the effects of wire-drawing, and the fallacy of by-pass. The great fault of these engines is this wire-drawing, and great loss of pressure between engine and boiler. In the Harlan & Hollingsworth Company designs, there is shown a very fine card, and the writer has cards from one of their latest designs, in which the loss between engine and boiler is less than two pounds. The *Mohican's* main bearings have showed the following wear in one year: Nos. 1, 2, 5 and 6, each 0.006 inch; No. 3, 0.004 inch; No. 4, 0.008 inch; average, 0.006 inch.



CARDS FROM PORT ENGINE OF NEVADAN.

SINGLE SCREW STEAM LIGHT VESSELS.

(Concluded.)

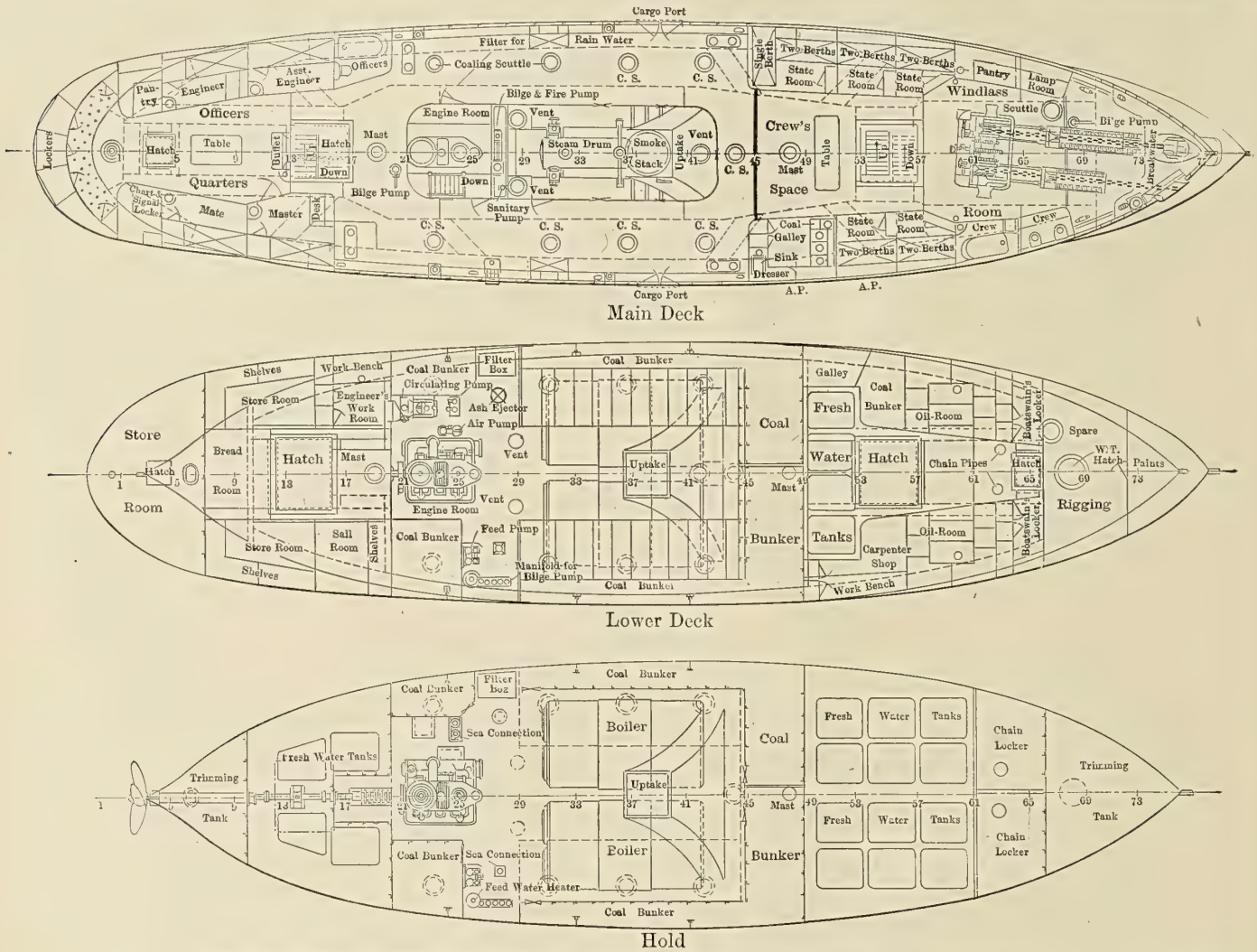
THE MACHINERY.

The propelling machinery consists of one vertical, direct acting, open-front condensing fore-and-aft compound engine, with cylinders 16 and 31 inches in diameter and a stroke of 24 inches. This engine drives a right hand four-bladed cast steel propeller 7 feet 9 inches in diameter and 10 feet pitch. The pitch ratio is 1.29.

The engine cylinders are cast separately, with barrels finished 1⅛ inches thick. The ports are proportioned for a maximum steam velocity of 8,000 feet per minute, and an exhaust velocity of 5,000 feet per minute, with a piston speed of 600 feet per minute. A balance cylinder, 6 inches in diameter, is fitted on top body and 2¼ inches in the guide and stuffing box. The reversing links are of the Stephenson double bar type, 3¼ inches wide and 1⅛ inches thick. The eccentric rod pins are 15 inches between centers. The link pin has a diameter and length of 2½ inches.

The eccentric rods are secured to the straps by a tee, forged on. The upper ends are forked, and fitted with composition journal bearings. The eccentric sheaves are of solid cast iron for the high-pressure cylinder, and for the low-pressure cylinder are made in two parts, divided through the center of the shaft. The larger part is of cast iron, and the smaller of mild steel. The straps are of cast steel, 3 inches wide. The extreme throw of the eccentrics is 5 inches.

The bedplate of the engine is of cast iron in one piece, with four main bearings. The main bearing brasses are 9¼ inches long, and filled with anti-friction white metal. The caps are of cast



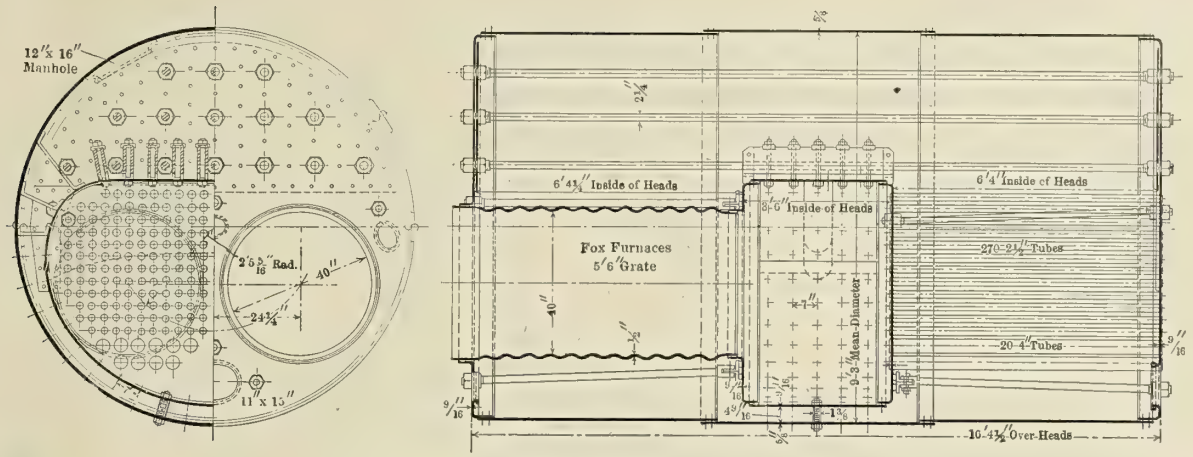
THREE DECK PLANS, SHOWING THE GENERAL ARRANGEMENT OF THE ACCOMMODATIONS AND MACHINERY.

of the receiver cover, with a piston for taking the weight of the low-pressure valve. The pistons are of cast iron, about 5 inches deep, the low-pressure being hollow. Piston rods are of machinery steel, 3½ inches in diameter. Crosshead blocks are of mild steel forged in one piece about 6 inches square, the connecting rod pins being 3½ inches in diameter and 4 inches long. The connecting rods are 54 inches center to center, forged of mild steel, with a fork at the crosshead end and a tee at the crank pin end.

The high-pressure valve is of the piston type, with a travel of about five inches; the low-pressure valve is a double ported slide valve. Both valves under full gear will cut off at about three-fourths stroke. The lead is about 7/32 inch at top and 13/32 inch at bottom. The valve stems have a diameter of 1½ inches in iron. The cap bolts have a diameter of 1¾ inches. The cylinders are supported on the back side by the condenser and back columns cast in one piece, of iron. On the front side are two steel columns, 4 inches in diameter, highly polished, and secured to the cylinders and bedplate by through bolts and nuts.

The condenser contains 800 square feet of cooling surface, the tubes being of the best quality of brass, ¾ inch outside diameter, of No. 18 B. W. G. The tube sheets are of Tobin bronze, 1 inch thick. The main exhaust pipe from the low-pressure cylinder is of cast iron, ⅞ inch thick, and measuring about 7 by 13 inches.

The crank shaft is of forged steel, 7 inches in diameter, with crank pins 7 inches in diameter and 8½ inches long. The crank webs are 5¼ inches thick. The couplings, which are forged on the shaft, have a diameter of 14½ inches and a thickness of 2⅜



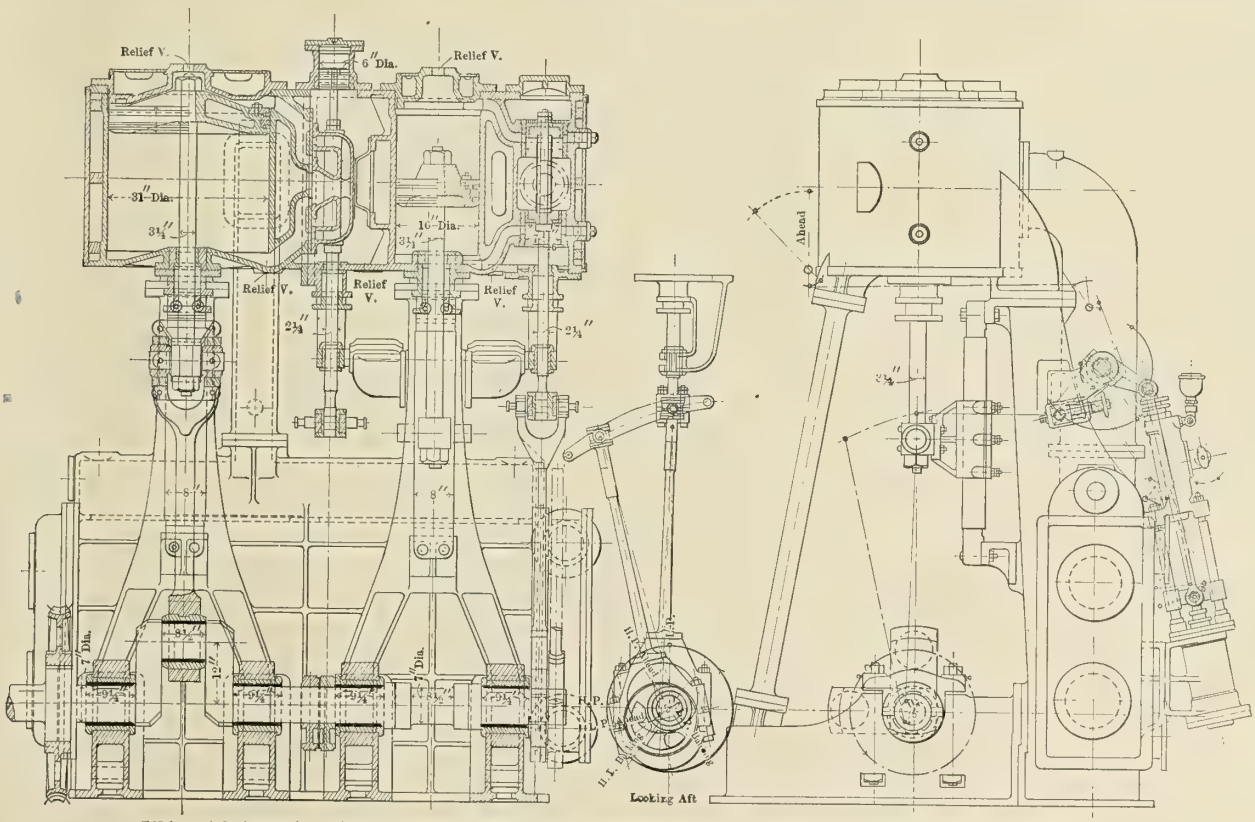
ONE OF THE TWO MAIN BOILERS IN THE NEW LIGHT VESSELS.

inches. The thrust shaft is 7 inches in diameter, and is provided with seven thrust collars forged on, and so designed that the maximum thrust does not exceed 50 pounds per square inch. The intermediate shaft has a diameter of 7 inches, and the tail shaft, 7¼ inches. The after end of the tail shaft is turned to a taper of ¾ inch to the foot, to fit the propeller hub, which has a length of 17 inches. All the shaft couplings are fitted male and female for centering.

Steam is furnished by two boilers, of the gunboat type, with a mean diameter of 9 feet 3 inches and a length of 16 feet 4½ inches. The working pressure is 100 pounds per square inch. The steam space measures 269.2 cubic feet. The heating surface of each boiler is 1,437 square feet, with a grate surface of 36.6 square feet. The ratio is thus 39.26 to 1. Each boiler has two Fox corrugated furnaces, with an inside diameter of 40 inches, and a thickness of ½ inch. Each grate has a length of 5 feet 6 inches. Each boiler has 290 tubes, measuring 6 feet 4 inches between heads. Two hundred and seventy of these are 2½-inch tubes and twenty are 4-inch tubes. The shell is formed in three courses of one plate each, ⅝ inch thick, with double riveted circumferential seams, and triple riveted longitudinal seams with double butt straps. The boiler heads have a thickness of 9/16 inch, with reinforcing plates inside, ⅜ inch thick, for the ends of the longitudinal stays. Combustion chamber plates are 9/16 inch thick. A steam drum is fitted, 10 feet long and 40 inches in diameter, with a dry pipe for taking off the steam.

The funnel measures 45 feet above the grates, and is built double. The lower and upper courses of the inside stack have thicknesses of 3/16 and ⅛ inch; the outer casing is ⅛ inch thick.

The air pump is independent, of the vertical, twin cylinder, beam type, with one steam cylinder, 7½ inches in diameter, and two air cylinders, each 12 inches in diameter and 8 inches in stroke. The circulating pump is of the centrifugal type, driven by a vertical direct connected engine, 5 by 5 inches. The feed pump is of the vertical, duplex piston type, with a stroke of 6 inches, and with steam and water cylinders respectively 6 and 4 inches in diameter. The suction and discharge pipes are 4 and 3 inches in diameter. The fire, deck and bilge pump is located in



THE MAIN ENGINE: VIEW OF FORWARD END, AND SECTION THROUGH CYLINDERS, LOOKING FROM STARBOARD SIDE.

the upper engine room. It is of the horizontal, duplex type, with a stroke of 10 inches, and with steam and water cylinders 9 and 5¼ inches in diameter. The suction and discharge pipes have diameters of 4 and 3 inches respectively. The sanitary pump is similar to the feed pump, but has cylinders 4½ and 3¾ inches in diameter, with a stroke of 4 inches.

THE FITTINGS.

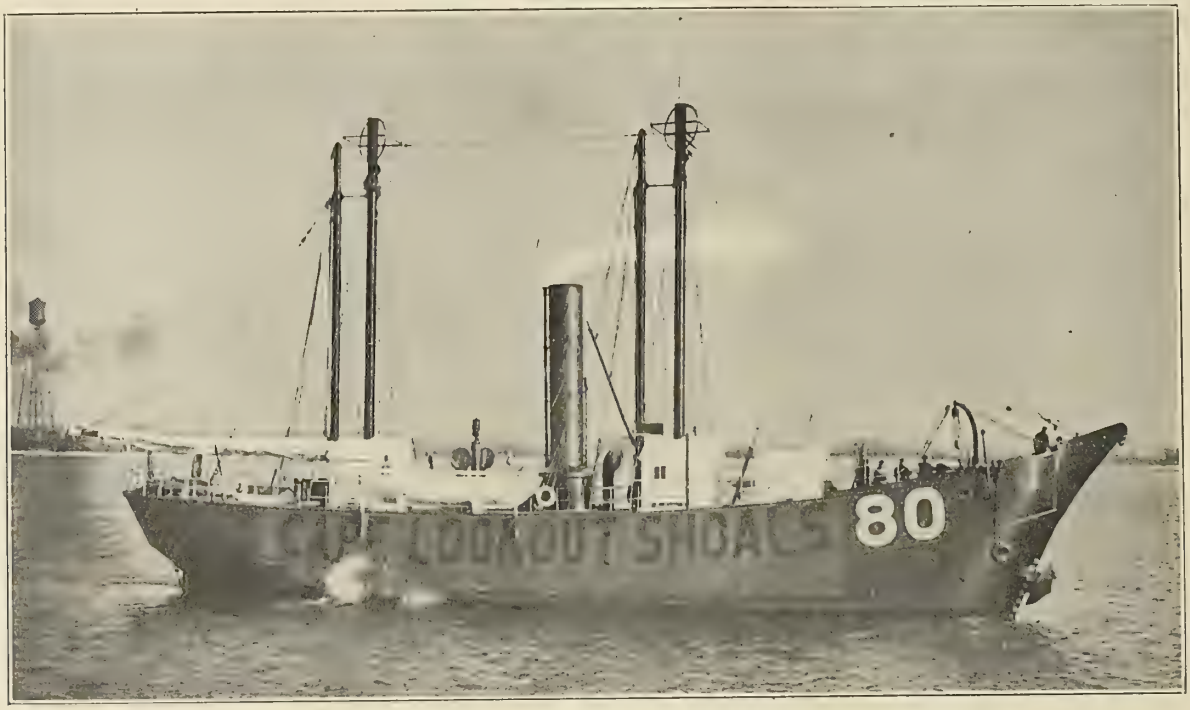
The lantern houses are of extra strong construction, and securely fastened to the deck. All fittings are of extra heavy brass, and the tops are covered with No. 4 canvas. The pilot house is built of white pine and securely fastened with galvanized through bolts; the top is fitted with a rail of galvanized iron. A steel break-water is located forward, being 3 feet 9 inches high, and of 10-pound plates, with a 2 by 2 by ¼ inch angle fitted around the upper edge, and bottom angles for connecting to the deck beams. Stiffening angles are also fitted.

The engine and boiler casings are made of 10-pound steel plates, stiffened by angles fitted inside, 30 inches apart and measuring 3 by 2½ by ¼ inches. The top and bottom angles are respectively 2½ by 2½ by ¼ inches and 3½ by 2½ by 5/16 inches. Five composition air ports are fitted in the drum room casing and two in the engine room casing, the glass having a thickness of ¾ inch. The engine and boiler room casings on the main deck contain the engine room hatch, lockers, steam drum, pumps, uptake from boilers, also part of funnel, ventilators, etc.

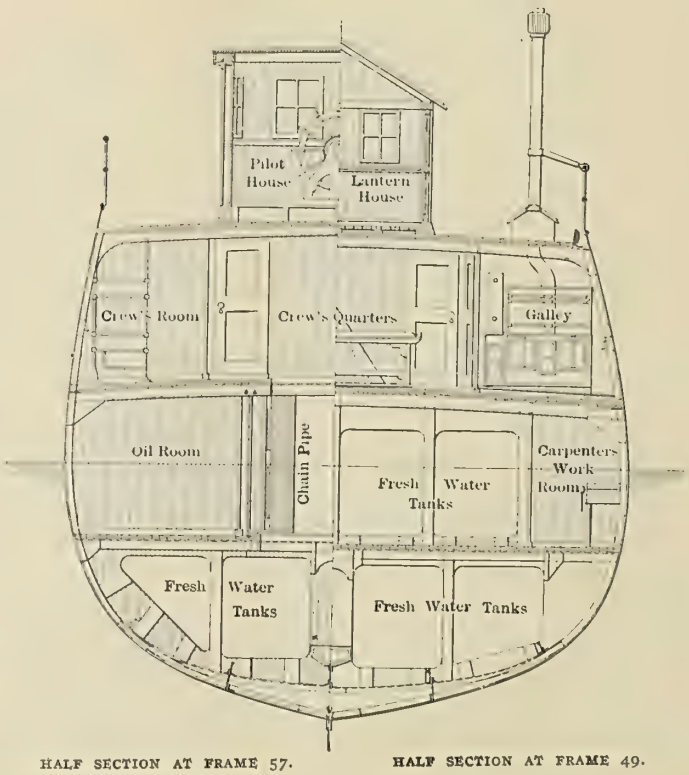
Four state rooms, fitted aft on the main deck, are arranged respectively for the master, mate, engineer and assistant engineer. Their mess room is on the center line of the ship between the pairs of state rooms. The bath room is located just forward of this accommodation, on the port side, and a pantry aft. The crew are located forward of amidships in five state rooms containing a total of eleven berths, with mess room between the rows of state rooms, and galley on the starboard side. The bath room for the crew is forward of the state rooms, on the starboard side alongside the windlass room, with pantry and lamp room on the port.

The lower deck contains under the forward end fresh water tanks, with a carpenter shop, oil room, spare rigging stowage, paint room, coal bunker, crew's galley and a number of lockers. Aft of the engine space are a sail room, engineer's work room and a number of store rooms, while coal bunkers are fitted in wake of the engines. The hold contains fresh-water tanks, chain lockers and trimming tank forward of the thwartship coal bunker, and fresh-water tanks and trimming tank aft of the engine.

In the pilot house is fitted a complete outfit of hand steering gear, with a hard wood wheel. All necessary ropes, etc., with a spare tiller and quadrant on the rudder head, are installed, the steering chain being ⅝ inch. There is also a complete system of brass speaking tubes, 1½ inches in diameter. The fog signal apparatus includes a deep toned chime whistle, 12 inches in diameter, fitted with a compound automatic whistle valve, and mounted at the top of the funnel. The fog bell is of 1,000 pounds weight, in a steel frame located forward of the pilot house. The



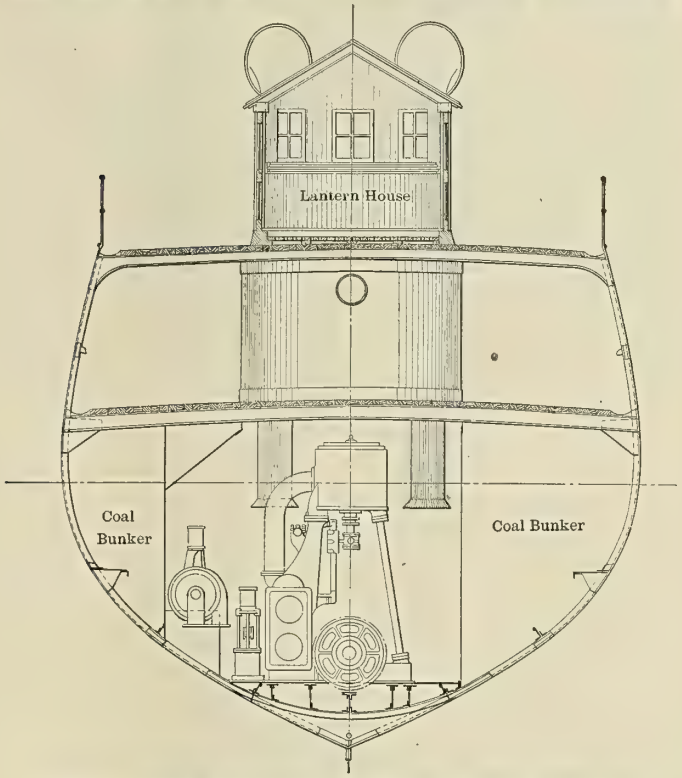
LIGHT VESSEL NUMBER EIGHTY, A PROTOTYPE OF NUMBERS EIGHTY-FOUR AND UPWARDS.



HALF SECTION AT FRAME 57. HALF SECTION AT FRAME 49.

running whistle has a deep-toned chime, and is 8 inches in diameter. The masthead lights are hoisted by hand gear with iron drums, the hoisters being firmly secured on the deck on a bedding of yellow pine.

A steam windlass with 9-inch steam cylinders is fitted, with two gypsies and two wild-cats for 1⅝-inch stud link chain. The chain stoppers are made of cast steel, with springs 6 feet long for the center hawse pipe and 5 feet for the starboard pipe. The steam capstan has two cylinders 5 inches in diameter and 8-inch stroke, with steam valve operated from either the spar or the main deck. There is one harbor anchor, weighing 1,800 pounds, one kedge, weighing 340 pounds, and one mushroom mooring anchor. The anchor davit is 7½ inches in



SECTION THROUGH ENGINE ROOM, AT FRAME 20, LOOKING FORWARD.

diameter, and designed for lifting the 7,500-pound mushroom mooring anchor with 25 fathoms of 2-inch stud link chain suspended.

The vessel is fitted with a foremast, a mainmast and a main tri-sail mast, the two former serving as lantern masts. They are built of steel, with an outside diameter of 16 inches, which is uniform to the hounds. The plates are 12½ pounds thick. Three stiffeners are fitted, 3½ by 3 by ⅜-inch angles extending the full length. These masts are provided with guide rails on which travel the bracket rings carrying the lens lanterns from the deck inside the lantern house to the lantern height when hoisted aloft. The tri-sail mast is made of one stick of Oregon pine of a diameter of 14 inches. The main boom, 11 inches in diameter, is 38 feet long; the gaff, 20 feet in length, has a diameter of 7 inches. The standing rigging is of galvanized steel rope. The running rigging is of Manila rope. A power boat, 21 feet long, and a whale boat, 23 feet by 5 feet 9 inches, are carried on the starboard and port sides respectively on the spar deck. The davits have diameters of 5½ and 5 inches for the power boat and whale boat respectively.

Another Race for the America's Cup.

While such keen rivalry is being manifested by the great steamship companies for the speed-supremacy of the Atlantic ocean, another challenge is reported to be on its way to the United States from Sir Thomas Lipton for another race to be held in 1908 for the famous trophy captured so long ago by the *America*. Such an event will be eagerly welcomed by yachtsmen the world over.

The Chilian Steamship Lebu.

There was launched from the yard of Earle's Shipbuilding & Engineering Company, Limited, Hull, last November, the steamship *Lebu*, which has been built to the order of the Compañia Sud Americana de Vapores. This is a sister ship to the *Teno*, which was launched from the same yard a few weeks ago, and has sailed for Valparaiso, where both are owned. Our photograph is the only one taken of either vessel, the dimensions of which are: length, 340 feet; breadth, extreme, 40 feet; depth, molded, 24 feet.

She has been built of steel to Lloyd's 100 A1 class, and is fitted for carrying a large quantity of water ballast in cellular double bottom and aft peak tank. She will carry about 3,950 tons deadweight, and has a large capacity for cargo. She has a poop, bridge, and top gallant forecastle; two pole masts of steel, each fitted with derricks and all necessary cargo gear, including a 30-ton steel derrick stepped on deck for heavy lifts. There are six powerful silent steam winches of the Earle Company's special make; two geared steam winches, and two steam

THE STEAMER LEBU RECEIVING FINISHING TOUCHES.

coaling winches by Clarke, Chapman & Company, a steam windlass by Emerson, Walker & Thompson; and steam steering gear by Davis & Company, fitted under the bridge.

The hatches are arranged at the sides of the vessel in pairs, with chafing bulkheads in 'tween decks and holds to allow of a rapid discharge of cargo into lighters. For bunkering the vessel, a system of cranes and shoots operated from coaling winches on the bridge has been adopted.

A commodious house has been provided at the fore end of the bridge for the captain's room and chartroom. The saloon is placed at the fore end under the bridge and the officers and engineers are also berthed on this deck in rooms at sides of casings. The petty officers, seamen and firemen are accommodated in the forecastle.

The machinery consists of a set of triple expansion engines with cylinders 23, 37 and 61 inches in diameter by 42 inches stroke, working at a pressure of 170 pounds per square inch, and supplied with steam by large single ended cylindrical boilers. Economy in coal consumption and in upkeep of engines and boilers has been carefully considered in the design of the machinery, all working parts and bearing surfaces being extra large.

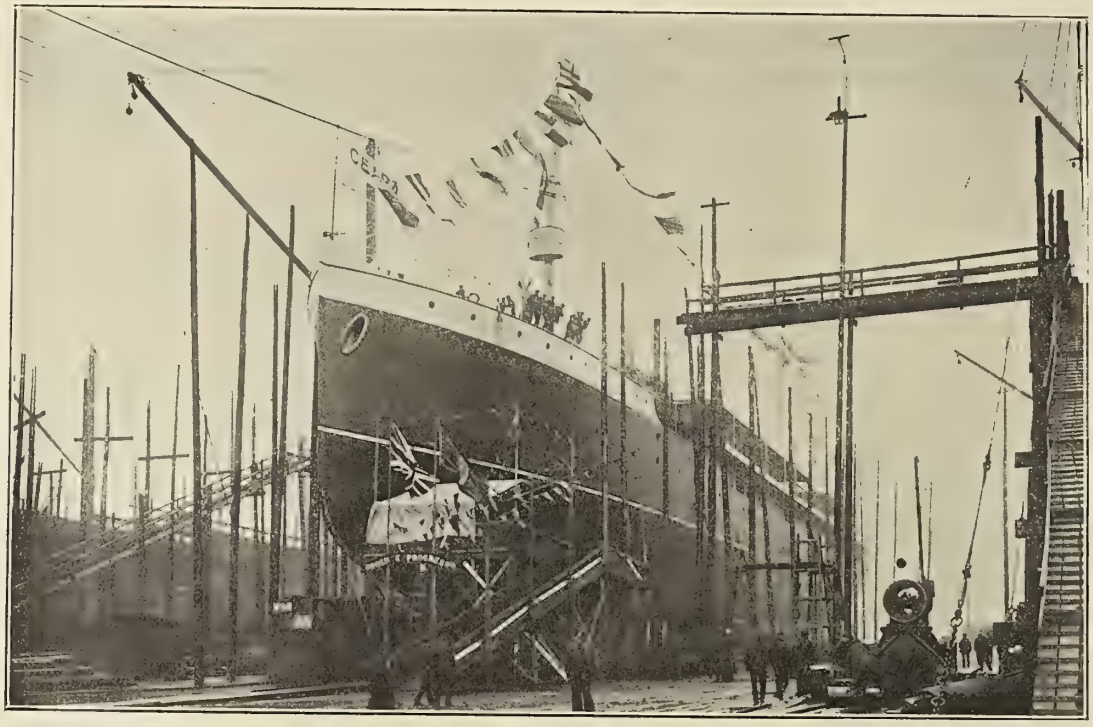
A Brazilian Steamer.

The *Ceara* is the first of six steamers built for the Lloyd Braziliero by Messrs. Workman, Clark and Company, of Belfast. Each vessel is 354 feet in length, and has a gross tonnage of about 3,500 tons. She was built under Lloyd's special survey to qualify for their highest class. She also fulfils the Board of Trade requirements for a foreign going passenger steamer. In the design and arrangement, the special requirements of the South American coast passenger and cargo trade have been carefully considered, and when completed she will be found to be a most comfortable and luxurious steamer. Accommodation will be provided for upwards of 170 first class passengers, 20 second class, and 300 third class.

The first class staterooms are placed in the upper deckhouse and on the main deck, and a number of cabins de luxe are provided—these include a large sitting room, bedroom, lavatory and bathroom. All these rooms are large, airy, and well lighted apartments. The first class dining saloon is situated on the main deck, and extends the full width of the vessel. A wide staircase leads from this saloon to the main entrance hall on the upper deck. This hall will be used as a lounge, and from it broad central corridors run fore and aft, with the staterooms opening off on each side. The cabins de luxe are placed around the entrance hall. Large double doors on each side open out on to the deck.

The main staircase continues up from this deck to the shade deck entrance hall. Opening off the forward end of this hall is the music saloon, and off the after end is the smoke room.

STERN VIEW OF THE CEARA ON THE WAYS.



BOW OF THE CEARA, JUST PRIOR TO THE LAUNCHING OF THE SHIP.

Both of these apartments are large, lofty, and well lighted, and will be suitably furnished. On each side of the hall wide double doors open out on to the shade deck, where ample promenading space is provided. A number of additional first class staterooms and the officers' rooms are placed in the deckhouse at the forward end of the shade deck.

The second class passengers' rooms are situated on the main deck forward of the boiler casing. The dining saloon is arranged in the center of the vessel, with the staterooms opening off on corridors on each side. The steerage quarters are fitted up at the forward end of the main deck, and include a separate room for women. A portion of the steerage will be fitted up with iron beds, and a portion with hammocks swung from the beams.

The engineers' and petty officers' rooms are placed in the midship house on the upper deck, while the crew are berthed in the top gallant forecastle. The sanitary arrangements for each class are receiving special attention, while the galleys and pantries will be provided with the most modern appliances. Electric lighting will be fitted throughout the vessel, while all the living compartments and public rooms will be well ventilated by natural and artificial means.

The cargo space is divided into four holds, by watertight steel bulkheads, which extend to the upper deck. The holds are fitted with suitable hatchways equipped with eight powerful hydraulic cranes capable of rapidly loading and discharging the cargo. Baggage and parcel rooms have been arranged for passengers' luggage, and mail and bullion rooms are being fitted up.

The propelling machinery is being constructed in Messrs. Workman, Clark & Co.'s Belfast yard, and consists of two sets of triple expansion engines, and three steel cylindrical multitubular boilers, working under Howden's system of forced draft. An auxiliary boiler is provided for supplying steam for the auxiliary engines and deck machinery.

CLEANING MARINE BOILERS.

BY LIEUTENANT H. C. DINGER, U. S. N.

The introduction of watertube boilers, both in the naval service and the merchant marine, has caused new methods of cleaning to be introduced. A general description of these later methods, more particularly as carried out in the naval service, should be of interest and value. With this idea in mind the following notes and description of methods of cleaning marine boilers in service are submitted.

CLEANING FIRE SIDES AND EXTERIOR OF BOILERS.

When steam is taken off boiler the cleaning of the grate and fire sides of boilers is first attended to. When fires are out, the furnaces are hauled and ash pans cleared out. After the boiler is cool, sweep tubes, overhaul grate surface, bridge walls, baffling, and clean out combustion chambers.

Grate Surface.—This is overhauled by cleaning out all clinker that adheres to the bars or bearers, especially cleaning the grooves on top of bars. Bars that are burnt out in places, or that are badly warped, are taken out, and other bars are put in their places. New bars should be put in the back section and old bars kept in the front, so that the bars most likely to come down will be in front. Care should be taken to keep the surfaces of uniform height. If high bars are put alongside of deeply burnt ones, the new ones will burn out more rapidly than if the surfaces are kept uniform.

Bridge Walls.—Any clinker adhering to the bridge wall is removed and bricks that have become loose, broken or have fallen out, are replaced. Fire clay is used to make the mortar for securing the bricks.

Tubes and Combustion Chamber (Shell Boiler).—Tubes are swept by means of the steam lance and hand brushes, having wire bristles. The soot falls into the combustion chamber, whence it has to be removed. The sides of the combustion chamber are cleaned with wire brushes. The tubes, and in fact the whole fire side of the boiler, can be very well cleaned by putting the boiler compartment under forced draft and opening the furnace door and dampers. The draft will blow through the boiler and up the stack, and will carry along with it the loose soot and cinders.

Tubes and Baffles (Watertube Boilers).—The exact method of cleaning will depend upon the type of boiler. General methods of cleaning some of the most common types will be described later.

Babcock and Wilcox Boiler.—A large part of the soot collects on the horizontal baffle, whence it can be removed by means of hand rakes worked through the lower side door in the casing. In order to keep the soot from falling into the fire room, a few of the baffle bricks are taken out just inside the casing door. When this is done, the soot drops through these openings and into the ash pans. The soot collecting on the upper tubes can be dislodged by means of the steam or air lance, or, if this will not do it, by means of brushes or pieces of flattened pipe. Some arrangements of brushes which can be hauled through between each two rows of tubes, by means of lines, are used. Old condenser tubes, flattened out, make a good tool for scraping the soot off the tubes. These can be worked either through the side doors, from the grate or from the space above the tubes.

Many vessels are fitted with both an air and a steam system for tube blowers. With steam there is some likelihood of the moisture rusting the tubes when the boiler is cold. The moisture of the steam may also sometimes cause the soot to bake hard on the tubes. It is, however, generally much easier to get an abundance of pressure with the steam than with the air, since this depends on the capacity and the efficiency of the air compressors supplied.

Where a good forced draft air pressure can be obtained, it is ordinarily not necessary to use hand brushes, except where the soot is baked on. The boiler compartment is put under air pressure, furnace and ash pan doors closed, one side door is opened at a time, and the current of air takes the soot with it and drives it out of the smoke stack. While the draft is on, the steam or air lance is used through the dusting doors, loosening up the soot so that the draft can take it up. In this way the tubes can be cleaned in a short time, and with very little manual labor. Precaution should be taken to see that there is a good beam wind during the time that tubes are being swept with forced draft. This will prevent the soot and cinders from being blown over the upper parts of the vessel.

Express Boilers.—The outside of tubes can be cleaned by using the steam or air lance through the cleaning doors provided in the front casing, and by use of bars, scrapers, brushes or steam lance from the furnace. The soot, as it is loosened from the tubes, drops into the furnace, or on the tops of lower drums, from which places it must be removed. After the heavy accumulation and hard soot is removed, the fire sides can be quite well cleaned by putting on heavy forced draft, and using the steam lance between the tubes. When baffle plates are fitted, special care should be taken that the soot accumulating upon them is removed.

Niclausse Boilers.—Baffle plates can be cleaned by pushing them back and forth, and using the steam or air lance between the headers. The soot on the tubes is removed by brushes, scraper or steam lance from the furnace or uptake. The loose dirt can be removed by the use of forced draft, as with other boilers.

Exterior of Boilers.—After the heating surfaces of boilers have been cleaned, the ash pans and exterior of boiler should be cleaned and overhauled. Ash pans are usually brushed out with wire brushes, and then rubbed over with oil. The sides of ash pans which form a support of the boiler should be chipped, carefully cleaned and painted with red lead or other suitable paint, several times a year. The unlagged surfaces of headers, drums, etc., of watertube boilers should be cleaned with wire brushes and rubbed over with oil. Cylinder oil or linseed oil can be used, or, if desired, specially prepared paint can be used for this purpose. The dogs, hinges, bolts and other fittings in the casing should be kept free from rust, and the threads of bolts for securing removable parts of casing should be smeared with graphite to prevent "freezing." Rusty spots on the outer casing or shell should be scraped, red leaded and then painted with the white or brown paint used for the outside coat.

CLEANING INTERIOR OF BOILERS.

The overhaul of the steam drum of watertube, or the interior of shells of shell boilers, consists of (1) overhauling, cleaning and repairing the internal feed pipes and automatic feed regulators, dry pipes and scum pans; (2) renewing zincs; (3) removing oil, dirt, or scale contained in the drum or shell.

Internal feed pipes often corrode, and their joints sometimes come loose. The holes in the internal feed pipe may also become partly plugged with grease, and so have to be cleaned. The automatic feed regulators require examination and cleaning. Pivot pins in regulators, especially if made of iron or steel, sometimes corrode and stick. They are usually made of brass, to avoid this sticking. If feed regulators are frequently overhauled

and cleaned, they will generally work with a fair degree of satisfaction. The zincs should be examined at least twice a year, and every quarter, if possible. When zincs become brittle and show signs of decomposition they should be renewed. With ordinary service in the navy, they will require renewal about every eight months. In watertube boilers, it is often desirable to fit zincs in some of the lower drums, as well as in the steam drum.

Removing Dirt.—The dirt lodging in the drums consists chiefly of the oil and mud that comes in with the feed water; this is sometimes mixed with rust and salt scale. This dirt is removed, and all parts of the metal wiped with kerosene (paraffin). The upper parts of the steam drum often show signs of rust, due to the presence of air. Kerosene is good for softening and loosening up rust, and is a good aid in removing oil, rust and dirt from the interior surfaces of boilers.

Tubes.—The deposit on the tubes consists of oil, mud, rust and salt scale. When no scale is present the deposit is soft, or has a leathery nature. Sometimes it is quite dry, and can be brushed off like dust. When scale is present, the deposit is hard, and will require a sharp edged tool to remove it.

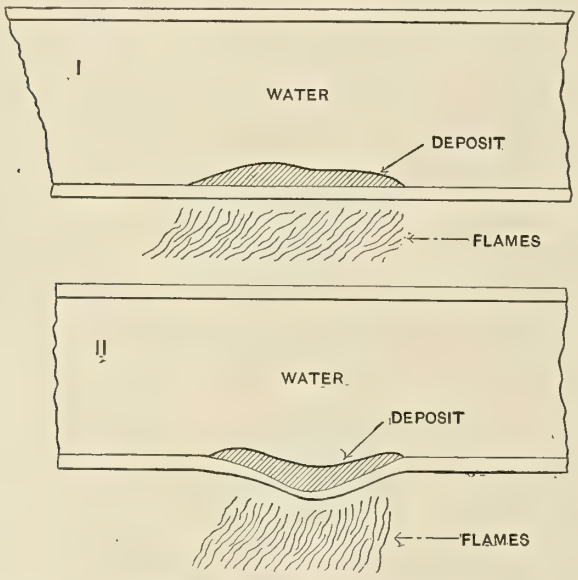


ILLUSTRATION SHOWING LOCAL COLLAPSE.

Bad Effects of Deposits on Heating Surfaces.—Local collapse of boiler material is in many cases due to overheating the metal, caused by the presence of scale or other deposit on the water side of the heating surfaces. Thus, taking any part of the heating surface, as a tube or crown sheet; the flames in striking the heating surface impart their heat to it, and the metal in turn gives it up to the water. If the water were not there, the heat would have to stay in the metal, and it would soon cause the latter to heat, soften, and then burn. Now, if in some places there is a non-conducting deposit on the heating surface, the metal at this place cannot readily give up its heat to the water: so, instead, the metal is heated, and afterwards becomes soft. The pressure will then cause it to bulge, and finally to collapse.

By using dirty or oily feed water, particles of dirt are apt to lodge on the crown sheets, combustion chambers and in the tubes. When salty water is allowed to get into the boilers, scale will be deposited on the heating surface. Scale may not be uniformly deposited, and as scale is a non-conductor, those places where the scale is thick are liable to become overheated. All deposits of scale, oil and dirt, being non-conductors, greatly reduce the efficiency of the heating surface, causing the boilers to have much less steaming capacity, and to be wasteful of fuel.

Scale is caused by the deposit of the various salts contained in sea water when the water is evaporated and converted into steam. It is especially obnoxious in producing leaky joints, especially at tube ends, and also at joints in the piping.

METHODS OF CLEANING WATER SIDES OF TUBES.

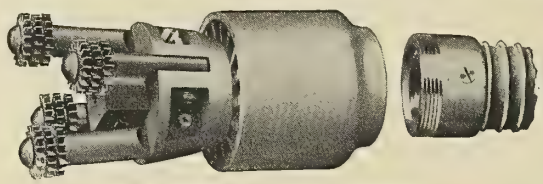
Indirect Means.—A great deal of the deposit can be removed by indirect means, such as boiling out, with kerosene or alkali, and blowing. Scale can be softened and in a large measure removed by repeatedly pumping up boiler with fresh water.

In the process of boiling out, carbonate of soda, caustic soda, or kerosene is introduced into the boiler, about 25 pounds being used per 100 square feet of grate, for watertube boilers. The boiler is partly filled with water, which is caused to boil at a pressure of 40 to 50 pounds, either by having a light fire in the furnace, or by making a steam connection to the lower part of the boiler. In the process of boiling, the soda and kerosene attack the oil deposit and cause saponification, the scum rising to the surface of the water. The water level is allowed to come a little above the level of the surface blow, which is then opened, and the scum driven off. This blowing with the surface blow is repeated at intervals of about an hour. The heavier residue of the deposit, chiefly rust and mud, gradually works its way to the bottom of the boiler, from where, by frequent use of the bottom blow, it also is blown out. The process of boiling and scumming is kept up for several days, and then all of the water is blown out. By this process the deposit has been very largely removed. What is left is usually a dry dust. The greater part of this dust can be removed by washing out the boiler.

Boiling out the boiler removes a very large part of the deposit in the tubes, and frequent boiling out will prevent any dangerous deposit from forming. It does not, however, thoroughly clean the tubes. An effective way of introducing the kerosene is to put it into the bottom of the boiler first, close boiler and then pump up with water. The kerosene will rise and float on the water, and in this way will slightly coat all the inner surfaces, and thus become well distributed. In order to thoroughly clean the tubes, mechanical means are usually necessary.

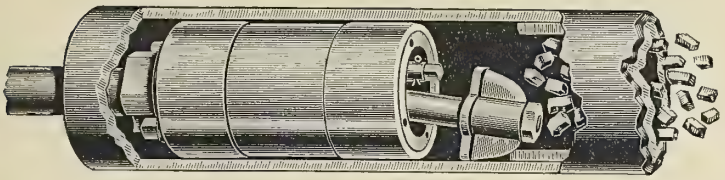
Cleaning Tubes by Mechanical Means.—Where the tube ends are accessible, either through hand hole plates or from the steam and water drums, the deposit can be removed by brushes and scrapers. It is usually best to run the scraper through first to loosen up the coating, and then use the wire brush to remove the loosened particles from the surface. Soft oily deposit can easily be removed by this means. After the tubes have had brushes run through them, they can be further cleaned by wiping them out with a swab made of rags or toweling, and dipped in kerosene or a solution of lye or soda. By this process the tubes can be made thoroughly clean and bright on the inside. When, however, the deposit contains considerable salt or lime, it is sometimes very difficult to get this out by the use of scrapers.

Turbine Cleaners.—For removing hard deposit, the turbine cleaner is very useful and efficient. This is attached to a hose which is connected to a salt water pump. When water pressure



THE WEINLAND TURBINE CLEANER.

is applied, the turbine revolves, and causes the arms carrying the cutters to revolve and spread. In this way the cutters are pressed against the surface of the tube, and remove the scale. The spray of water issuing from the turbine carries away the loosened particles, and washes them down to the header. In using the turbine it is entered into the tube end and pushed and hauled back and forth by means of the hose. When the turbine has been pushed through the length of the tube several times, all deposit will be found cleaned out. The Weinland turbine, made by the Lagonda Manufacturing Company, Springfield, Ohio, operates on a pressure varying between 100 and 200 pounds per square inch. It is advisable, for convenience, to put a valve in the section of hose

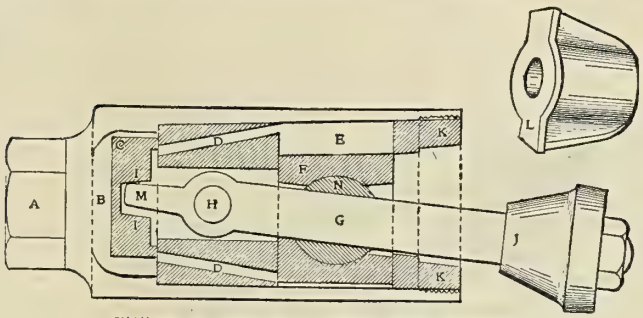


THE DEAN CLEANER WORKING IN A WATERTUBE BOILER.

next to the turbine, so that the pressure can be put on or shut off near the man that is operating it.

The Dean boiler tube cleaner is another handy mechanical device used for cleaning tubes of watertube boilers. It is made by the William B. Pierce Company, Buffalo, N. Y. This cleaner is operated by compressed air or steam. It is especially adaptable to hard scale, and is very largely used in power plants on shore. Its operation is as follows:

The nozzle *A*, attached to a hose or gas pipe of suitable length, carries compressed air or dry steam into the valve chamber *B*, and thence goes alternately through the ports *DD* into the piston chamber *E*. At a pressure from 40 to 80 pounds, the piston *F* moves the hammer handle *G* to and fro, imparting a vibrating motion to the hammer *J*. The handle of the hammer, being pivoted at *H*, works the valve *C* so as to cover the ports in alternation. The whole tool being inserted in the boiler tube, the hammer head vibrates with tremendous rapidity—from 3,000 to 4,000



SECTION OF THE DEAN BOILER TUBE CLEANER.

times a minute; and as it vibrates, striking the tubes thus fast with a succession of very light but very frequent blows, it jars the scale loose. For watertube boilers, a hammer-head with cutting edges and guards is used. This cracks the scale from the tubes, breaks it up, and a gust of steam or air drives out the loosened particles. The blow struck is a very light and rapid one, and does not mar the metal of the tube.

On small tube express boilers, cleaning chains are sometimes pulled back and forth through the tubes, to loosen the deposit. They are especially useful on curved tubes, where brushes and scrapers are difficult or impossible to use. Watertube boilers should have their tubes thoroughly cleaned, and each tube examined, about twice a year.

WASHING OUT BOILERS.

A great deal of loose dirt contained in the boiler can be removed by washing out the boiler. A salt water hose having connection to a good pressure is used. The hose is usually taken into the steam drum and pointed into the ends of the tubes. The lower plates of the headers or mud drums are taken off, and the force of the current of water carries with it such loose dirt as may be in the boiler, and washes it through the bottom openings into the fire room bilges.

On Babcock and Wilcox boilers the tubes may be washed out by taking off the top row of hand hole plates and pointing the hose into the tubes. When the hose is taken into the steam drum, it should be pointed successively into each of the upper steam supplying tubes, and also down the front headers.

The process of washing out will remove any loose accumulation of foreign matter introduced while cleaning, and it will remove any residue of lye or kerosene that has been used for loosening up the oil deposit, and which might cause priming. The washing out process must be thoroughly followed up to see that the loose dirt is completely washed clear of the boiler, and not merely washed to some other part of the boiler. After washing out, the boiler must be completely drained of the water used in washing.

CLEANING THE INTERIOR OF SHELL BOILERS.

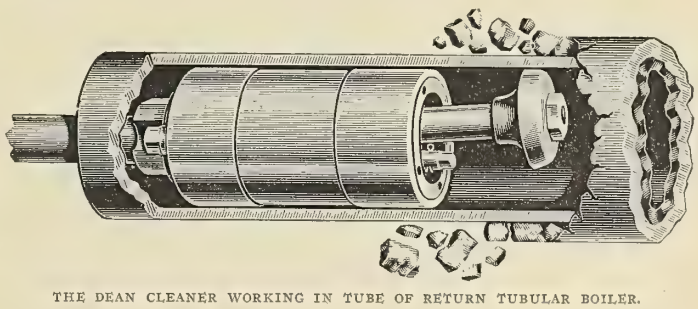
This work consists principally in removing the scale and deposit on the tubes and heating surfaces. Hot water and vapor keep the scale soft, while contact with the air causes it to become hard; therefore the boiler should not be opened until just before scaling is to commence. In pumping out the boiler, it is best to pump it nearly empty the evening before, while the boiler is still warm. Then allow the boiler to stay closed during the night. The vapor will keep the scale soft.

Scale is removed by scrapers, chisel bars and scaling hammers. The men work from the top down. Candles and portable electric lights are used to give light to the men, and their comfort can be materially increased by ventilating the boilers with portable electric fans. The parts that should receive the most attention in scaling are the crown sheets, tops of combustion chambers, the tube ends and tube sheets. The tube ends should be kept clear of scale, to avoid the salt which would cause them to leak. Increased efficiency can be obtained by smoothing up crown sheets and tubes by the use of coarse emery paper or sand paper. The bright surface insures the removal of all deposit, and also gives a surface upon which the scale and dirt will have less of a tendency to cling.

Another way to keep the scale soft while scaling is to allow the boiler to cool without pumping it out, and then open it up, just before scaling, and pump it out gradually as the scaling goes on. In this way the scale is kept soft, and can be scraped off with less effort. This method, however, makes the work more disagreeable for the men that have to do the scaling.

After the scale has been chipped and knocked off, the loose scale is hauled out from the bottom, the boiler is washed out with a hose, and the dirt drawn out through the lower manholes. Great care must be taken to see that all particles of scale and dirt are removed. Before closing the boiler, it should be carefully inspected to see that no rags, tools, candle ends or other material is left inside.

Scale in shell boilers may also be removed by special tube cleaning machines, such as the Dean boiler tube cleaner, the operation



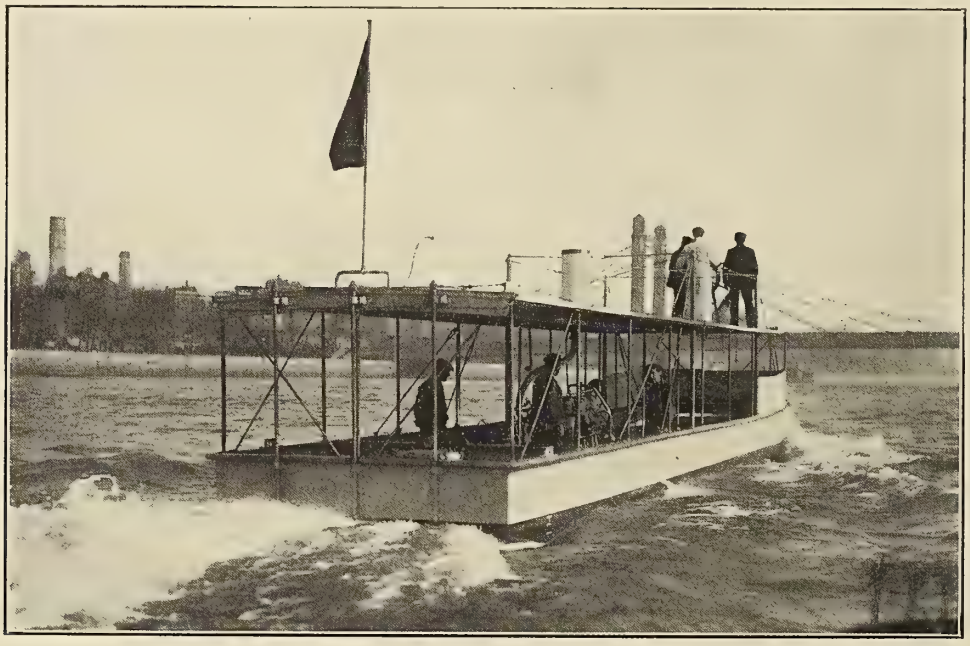
THE DEAN CLEANER WORKING IN TUBE OF RETURN TUBULAR BOILER.

of which has already been described. This cleaner will thoroughly remove the scale on the tubes of shell boilers, many parts of which are inaccessible to other means of cleaning. The cleaner will jar the scale loose, and also the corroded or incrustated metal of the tubes. It will thus show up any bad places, so that they may be remedied before a rupture takes place. The action of the hammer on the tube jars loose both the scale on the water side and also any hard soot or scale on the fire side; while the escaping steam or air blows the soot and dust out, thus thoroughly cleaning both water and fire side of the boiler.

The Light Draft Motor Launch Spider.

This new boat has been built by John I. Thornycroft & Co., Limited, Southampton, to the order of the English crown agents for the colonies, for service in South Nigeria. The hull is open, with a short deck over the fore peak, and protected from the tropical sun by a light wood awning, on which is placed the steering wheel forward, and curtains along the sides, of green Willesden canvas. The hull is subdivided by six watertight bulkheads, floor boards being fitted along the bottom of the boat, forming a deck. The length is 56 feet, with a beam of 9 feet and draft of 12 inches.

A peculiar feature of the launch is the position of the steering wheel. This has been placed in the front of the boat, above the awning, and is reached by means of a ladder from the deck below. The wires leading from the wheel to the rudders are carried along the side of the awning. Three single plate balanced rudders are used, as they are claimed greatly to facilitate steering with this light draft. The boat is propelled by two screws fitted on the same shaft, which work in a tunnel, the latter being of the maker's special design.



SHALLOW DRAFT MOTOR LAUNCH, SPIDER, SHOWING SQUARE STERN AND DECK ON THE FORE PEAK.

The engine is a four-cylinder Thornycroft motor, and the fuel used may be either petrol (gasoline) or paraffin (kerosene). The normal number of revolutions is 800, and at this speed the engine develops 48 brake horsepower on paraffin; when petrol is used, higher speeds are naturally obtained, and at 800 revolutions the engines developed 56 brake horsepower. As, however, the engine is intended to run at very low number of revolutions, approximately 380, it will develop in service not more than 25 brake horsepower.

The engine consists of two units of two cylinders each, bolted to a cast iron base plate, which is secured by bolts to a steel framework forming part of the hull. A small piece of hard wood packing is interposed between the base plate and the steel hull, so as to deaden noise and minimize vibration. The cylinders are each 6 inches diameter by 8-inch stroke, and have a fairly high compression. Both the exhaust and inlet valves are mechanically operated, and they are placed on opposite sides of the cylinders.

The Simms-Bosch low-tension system of ignition has been adopted for firing the charges of gas in the cylinders, and provision is also made for fitting a supplementary high-tension magneto system to be used, should the other, through any cause, fail. The speed of the engine is controlled by a ball governor, which regulates the supply of gas by opening or closing the throttle. A small air pump for maintaining a pressure of 4 pounds in the fuel tanks is operated from an eccentric keyed on to the governor spindle.

Two fuel tanks are provided, one on each side of the boat, with a capacity of 80 gallons. If the engine is using petrol, the latter is supplied direct to a single carburetor. If paraffin is being used, it is supplied to a vaporizer which is heated by the exhaust gases from the engine. This vaporizer consists of a metal box, into which the exhaust is led. Inside this box is placed a U-tube, through which the paraffin passes. The heat of the gases vaporizes the paraffin, which is then drawn into the cylinders. By a series of cocks, the fuel can be changed over from petrol to paraffin with very little trouble. All the necessary control levers are placed so that the attendant in charge can completely control the engine from one position. The engine can be run on half compression when starting.

The launch attained a mean speed of 8 knots on official trial, with a load of 4 tons and a draft of 12 inches.

An important feature of the motors is the arrangement for running on petrol or paraffin, as desired. A four-way connection is fitted in the induction pipe, the two horizontal branches going to the cylinders, the upgoing pipe leading to the paraffin vaporizer, and the downtake pipe to the petrol carbureter. Each of the latter pipes is provided with a throttle, so that if the motor is started up on petrol, the vaporizer throttle is kept closed, while if it is desired to change over to the heavier fuel after the engine has warmed up, the petrol throttle can be closed, and the paraffin valve opened.

Half compression cams are fitted to the exhaust cam shaft to facilitate starting up, it being easy to get up a fair speed by hand under this condition, and as soon as the engine begins to fire, the full compression is given, when the motor picks up quickly.

The first trip of the *Spider* was of four hours duration, on July 24, 1906. This was accomplished without a stop, and without the least trouble from the motor, which used ordinary American paraffin exclusively. After this the boat was put into commission, making regular runs, towing steel or native canoes, and delivering mails, etc.

A notable run was one of 384 miles made in August, this being accomplished in 48 hours 23 minutes, or an average of 7.68 miles an hour. The paraffin consumed was at the rate of

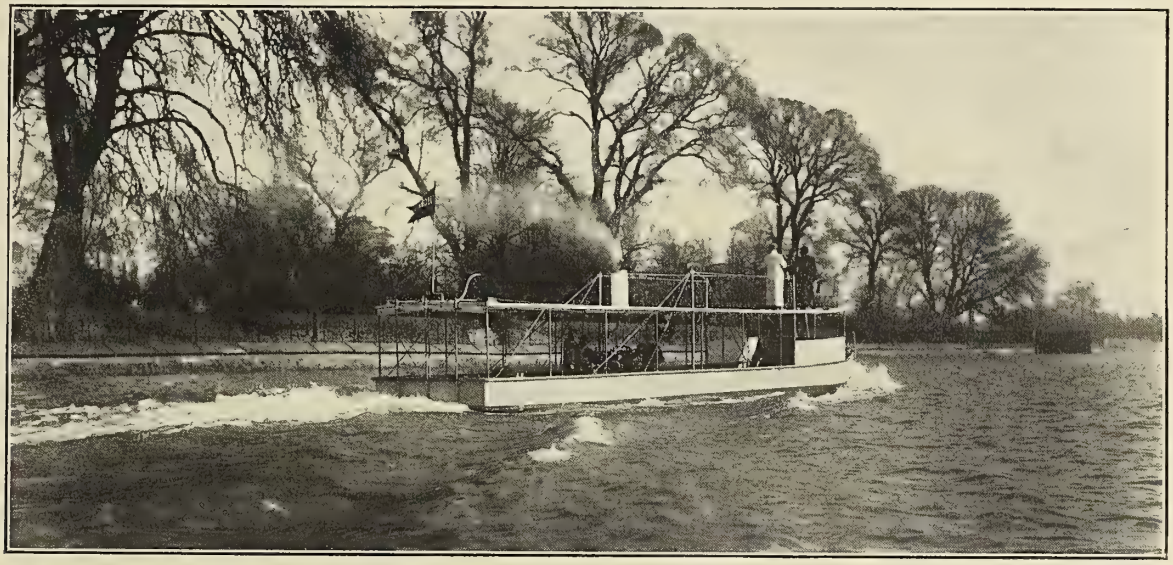
4.6 gallons per hour—an extremely economical figure under the exceptional conditions. No petrol whatever was used on this occasion.

Another good performance was a journey of 60 miles from Itu to Indibe beach (Afikpo), towing two fully loaded steel canoes, on December 25 and 26 last. This distance was covered in 14 hours 50 minutes, or at an average speed of about 4 miles per hour against the stream. The accompanying table, showing distances run, time under way, and consumption of fuel during certain periods, is worthy of note:

1906	Distance (miles)	Hours under way	Kerosene consumed
July	136	26.15	*107
August	440	61.24	171
September	666	113.39	351
October	452	78.40	280
November	916	162.25	546
December	832	139.55	504
Totals	3,442	580.98	1,959

*Imperial gallons.

For this period, the average consumption of kerosene per hour was 3.3718 gallons, or 0.805 pint per brake horsepower per hour. The makers state that the motor starts as easily on kerosene as on gasoline, and as the cost of the former landed at Calabar is exactly half that of the latter, the advantages of using kerosene are enormous, more particularly so with the very low consumption shown above. The cost of fuel per mile works out at an average of about 15 cents (7½ pence). A circumstance which speaks remarkably well for the ease and simplicity with which this type of motor may be handled, is the fact that hitherto inexperienced natives have, within a very short time, mastered the details to the extent of being able to dismantle and re-assemble it, while the *Spider* has been run for days together, and several hundreds of miles from its base, in charge of a native driver only.



THE STEERING WHEEL OF THE SPIDER IS PLACED IN A PECULIAR POSITION ON THE FORWARD END OF THE AWNING.

The Port of Antwerp.

The Belgian government has inaugurated a scheme for the expenditure of $40,000,000 (£8,220,000) in extending the port facilities of Antwerp. Belgium has practically no merchant marine, but Antwerp is one of the greatest ports in the world, the shipping entering the port being principally British and German, these two nationalities handling 77 percent of the total tonnage movement. For many years British shipping was far in the lead, and still controls more than 50 percent of the total, but German shipping is rapidly coming to the front. American shipping is represented by steamers of the Red Star Line, two of which, of 12,760 tons each, run from New York; two others, of 3,340 tons each, from Philadelphia, and a fifth, of 7,913 tons, from New York, Philadelphia and Boston, as the case may be. Other ships of this same line, flying British and Belgian flags, also make Antwerp their port, the above list including simply those under the American flag. For the year 1905, the total shipping entering the port consisted of 6,034 vessels, of an aggregate of 9,850,592 tons, or an average of 1,632 tons. In 1904 there were 5,852 vessels, aggregating 9,400,335 tons, or an average of 1,611. The increase represents 182 vessels, while the tonnage increase of 450,257 shows a gain of 4.8 percent. It will be noticed that the average size of ship entering the port is increasing.

The additional facilities to be provided in the port include a canal with nine basins, the whole of which is to be completed in ten years. The present construction, which is to be finished in four years, includes three and one-half miles of quays, and covers the cutting of the proposed new canal to such a distance as to include two of the nine open basins. These latter are to be constructed north of the canal, and at right angles to its general direction.

Figures for a Turbine Steamship Plant. Assuming the steam consumption of the turbines of the new Cunard steamship *Lusitania* to average 15 pounds per horsepower-hour when the turbines are developing 65,000 horsepower, it has been calculated that the boilers will have to evaporate each hour 435 tons of water, which would call for the consumption of 50 tons of coal per hour, or 1,200 tons per day. As the turbine requires for economical working a high vacuum, it is assumed that the condensers will call for about 50 pounds of circulating water for each pound of steam condensed. This means an hourly passage of 21,750 tons through the circulating pumps, or 522,000 tons per day. Each pound of coal consumed will require the passage through the furnaces of 14 pounds of air, making a total of 700 tons per hour, or 16,800 tons per day. This is equivalent to 21,000,000 cubic feet of free air per hour. With the average trip estimated at five days, it will be seen that the coal consumed will amount to 6,000 tons. The water evaporated will total 52,200 tons. The work of the circulating pumps will be represented by the passage through the condensers of 2,610,000 tons of water, or 60 times the entire weight of the ship and contents. The air requirements of the furnaces will amount to 84,000 tons.

The American Scout Cruiser Salem.

This scout cruiser, which was authorized by act of Congress of April 17, 1904, was launched July 27, 1907, by the Fore River Shipbuilding Company, of Quincy, Mass. The estimated speed, 24 knots, is greater than that of any other cruiser of the United States navy, being exceeded only by that of the torpedo boats and destroyers; and while it is slightly less than that of the English scouts, the difference in speed is more than compensated for by the ability to maintain the high speed in all conditions of weather, and by more than twice the coal capacity of the English scouts, and, consequently, a greatly increased radius of action. The plans call for a vessel of the following characteristics:

Length between perpendiculars	420 feet 0 inches
Length over all	423 feet 2 inches
Breadth, molded	46 feet 8 inches
Depth, amidship, molded	36 feet 5 1/16 inches
Draft, fully loaded	19 feet 1½ inches
Displacement, fully loaded	4,640 tons
Displacement on trial	3,750 tons
Draft on trial	16 feet 9½ inches
Total coal capacity	1,250 tons
Coal on trial	475 tons
Feed water total	100 tons
Feed water on trial	50 tons
Steaming radius at 10 knots, about	6,250 miles
Steaming radius at full speed, about	1,875 miles
Maximum brake horsepower, main turbine engines	16,000
Indicated horsepower, auxiliaries	400

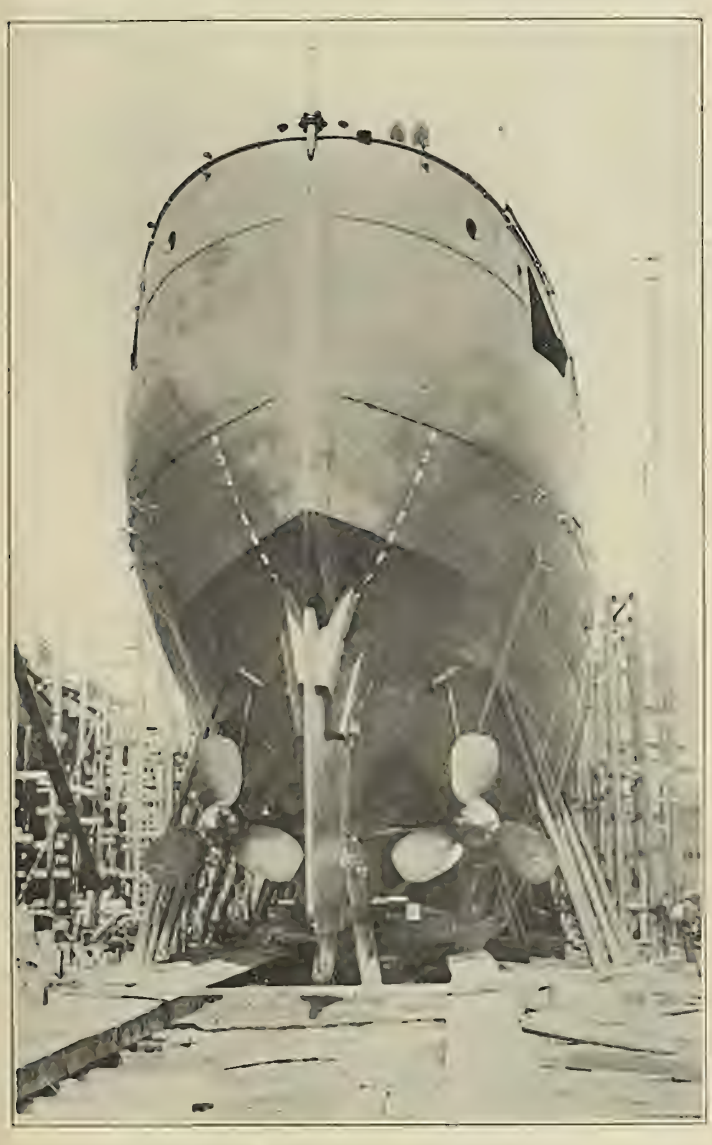
The freeboard of the vessel is greater than that of any other vessel in the navy, being, at the normal draft, 19 feet 8½ inches amidships, 34 feet at the stem, and 21 feet 6 inches at the stern. The high freeboard insures good seagoing qualities, gives great range of stability, and provides a safe and dry vessel under all conditions of weather. On account of the high freeboard it has been possible to provide commodious quarters for the officers and crew, well above the waterline. A forecastle has been provided above the main deck, for about one-quarter of the length, and deck houses have been arranged abaft the forecastle. Ample subdivision has been made to insure the vessel keeping afloat with no resulting serious change of trim or loss of stability, if several of the compartments are pierced below the water line.

THE AMERICAN SCOUT CRUISER SALEM AFLOAT AT QUINCY, MASSACHUSETTS.

In planning the structural details, the greatest care has been exercised to provide a hull which shall combine with lightness the strength and stiffness necessary to successfully withstand the severe shocks which the vessel may be called upon to undergo, and particular attention has been paid to the longitudinal strength of the vessel and to the strength of the watertight bulkheads, that they may be able to withstand the pressure due to the flooding of any compartment, and thus avoid endangering the vessel as a whole.

The hull is built of steel throughout, two longitudinal bulkheads being worked continuous throughout the engine and boiler spaces, one on each side, extending from the bottom of the vessel to the main deck, and inclined slightly inboard at the top. In order to avoid any break in the continuity of the strength of the vessel, the upper and lower strakes of these bulkheads extend well beyond the limits of the machinery spaces, forming large brackets gradually tapered off. Between these longitudinal bulkheads, and extending throughout the boiler and engine room, an inner bottom is worked, so that the vessel is well protected from injury in case of grounding.

There are five decks, designated as forecastle, main, berth, orlop and platform, respectively, the main and berth decks being continuous from stem to stern. Nickel steel protection of 80 pounds per square foot (2 inches thick) is worked on the shell plating for the length of the machinery space, including the dynamo room. This extends from about 3 feet 4 inches below the waterline to about 9 feet 6 inches above, abreast the engine and dynamo rooms, and 6 feet 6 inches above, abreast the boiler rooms. At the forward end of the machinery space and the after end of the dynamo room, partial athwartship bulkheads of 40

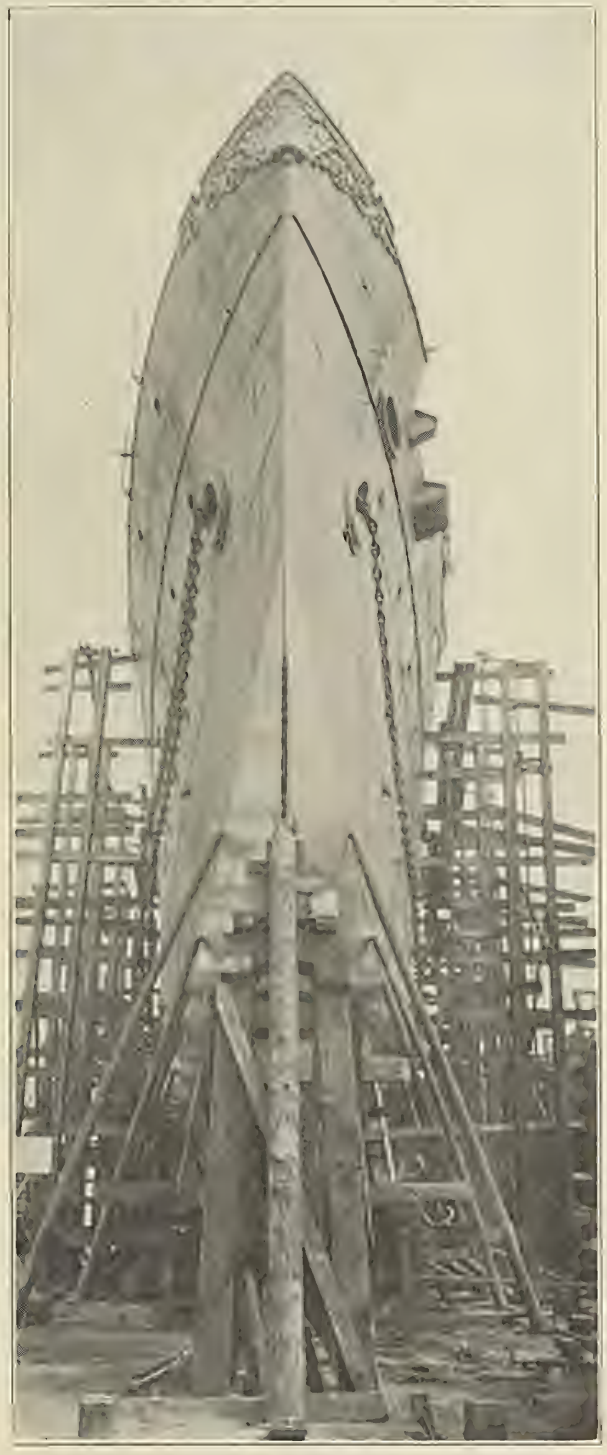


STERN VIEW OF SALEM, JUST BEFORE LAUNCHING.

pounds nickel steel are fitted, of the same depth as the adjoining side protection. Nickel steel protection is also fitted in wake of the steering engine.

The battery consists of two 5-inch and six 3-inch rapid-fire guns, and two 21-inch submerged torpedo tubes. The latter are of the side-loading type, with all necessary accessories, including air compressors and accumulators, and are installed in the torpedo room forward, one on each side. Four torpedoes for each tube will be carried. The magazines have been so arranged that about half the total supply of ammunition will be carried at each end of the vessel, and four ammunition hoists driven by constant speed electric motors will deliver ammunition to the guns. Battle order and range indicators will be fitted in accordance with the usual naval practice.

The engines are Curtis marine turbines, 120 inches in diameter, seven-stage reversible, located in separate compartments, of a combined brake horsepower of 16,000, arranged for outboard turning propellers when going ahead. The steam pressure at throttle valve will be 250 pounds. Maximum revolutions at full power will be about 350 per minute. The two bronze propellers are three-bladed.



BOW VIEW, SHOWING GREAT FREEBOARD AND SHARP PROW.

There are twelve watertube boilers of the Fore River "Express" type, placed in three watertight compartments, with a total grate surface of 693 square feet, and a total heating surface of 37,080 square feet (ratio 53.5 to 1). The working pressure will be 275 pounds per square inch. The steaming capacity will be such that all the steam machinery can be run at full power with an average air pressure in the firerooms of five inches of water. Four smoke pipes, each 75 feet high above the base, are fitted. An evaporating and distilling plant capable of evaporating and

condensing 16,000 gallons of water per day is installed, as well as a refrigerating plant of 2 tons capacity. The vessel will be steam heated throughout.

The ship will be lighted by electricity, about 600 incandescent lamps, 22 arc lamps and two 60-inch searchlights being installed. To supply the current for these lights and the various electric-driven auxiliaries about the ship, deck winches, ammunition hoists, ventilation sets, air compressors, etc., three 32-kilowatt steam-driven generating sets, of 125 volts pressure at the terminals, are installed in the dynamo room on the platform deck aft.

Two stockless anchors arranged to stow in the hawse pipes, and one navy type anchor stowed on a billboard, are fitted, with complete arrangements for handling and stowing the same. The windlass is of the vertical spindle type, with two wildcats and gipsy heads, and is installed on the main deck forward. The steam steering gear is of the usual navy type, with the steering engine located in a separate watertight compartment aft, and with the usual steering stations in the chart house and on the bridge.

Two masts are provided, the foremast being fitted for the installation of wireless telegraph. A room for the wireless telegraph instruments is located on the main deck amidships. The chart house and emergency cabin in the after end of the forecastle deck is of bronze. The chart house and the bridge above are supplied with the usual steering stands, engine telegraphs and indicators.

The arrangement of the quarters provides accommodation for a commanding officer, twelve wardroom officers, five warrant officers, and 340 men. The quarters for the officers are located in the after portion of the vessel, with the usual staterooms, messrooms, etc., as customary in the naval service. The amidship and forward portions of the vessel are given up to the crew, with the usual lavatories, dispensary, sick bay, etc. Quarters for the chief petty officers are provided on the orlop deck forward. The houses on the main deck contain the galleys, bakery, breadroom, blacksmith shop and wireless telegraph room. A large workshop is provided on the berth deck between the engine hatches, and the firemen's washrooms are also located on the berth deck, between the uptake inclosures.

The following boats will be carried on the vessel, and will be handled by davits: one 28-foot steam cutter, one 33-foot launch, two 30-foot cutters, three 28-foot cutters, one 30-foot whale boat, one 30-foot gig, and one 14-foot dinghy.

The Japanese merchant marine in 1880 amounted to 63,486 gross tons. On December 31, 1906 this had increased to 1,034,634 tons and included 1,446 steamships, 21 of which exceeded 6,000 tons each.

Navigation by Celestial Observation.

BY STEPHEN P. M. TASKER.

To locate yourself:—Did you never want to do this accurately, to be a real explorer and to know where you are from day to day—what progress in a given direction you are making, and to put on paper from scientific observations of the heavenly bodies the exact course you have followed? Did you never have a desire to be able to do this, and think it too much to take up, and that you had not the time? I will try to show you it is easy, and that it does not take long to thoroughly understand all that is necessary to know in locating yourself by latitude and longitude; the instruments used, their cost, weight, etc., and a simple knowledge of the few heavenly bodies necessary. Or, to put it in other words, would say that should you be dropped from the clouds at any place on the ocean with but your sextant, watch and tables, you can find your location with absolute certainty to within a fraction of a mile. When you can know to within a half mile your exact position, you will realize along how small a portion of an unknown coast you can operate and carefully map. There are any number of unexplored parts for the amateur to work in, and the geographical department is only too glad to receive what information of these places you can give. If you knew how far "out" many of the charts and maps of wild and partly explored regions are, to say nothing of the unexplored places, it would make you realize the broad field of instructive and interesting work that lies in your power, if you will but avail yourself of it, with the expenditure of very little time and money.

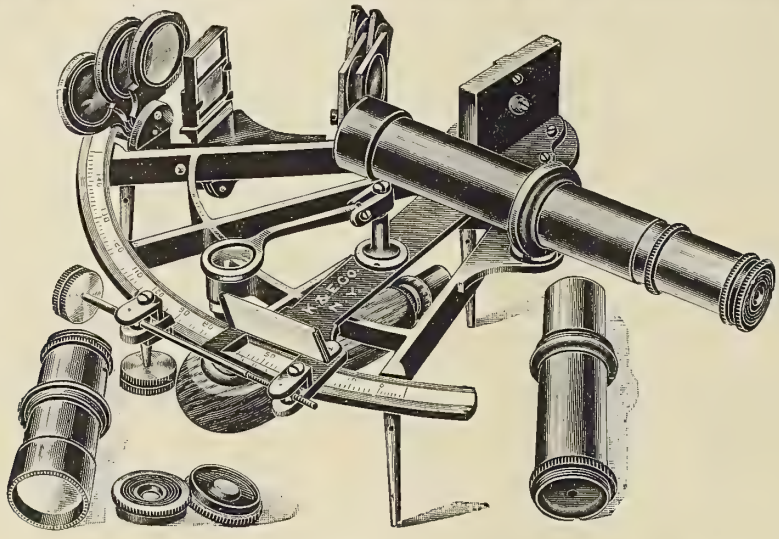


FIG. I.

A little knowledge, or being partially outfitted in this respect, is an embarrassing or dangerous state. Taking one expedition in particular for example, although equipped to place themselves for latitude, I understand they were unable to do so for longitude. As their course lay almost east and west, you can see the importance of longitude reckoning, and the unimportance of latitude in their case. But of course you want both, as one is of little good without the other. And why so many expeditions venture into the unknown, expecting to chart and find themselves without proper instruments and knowledge is something I do not understand. If you think you can trust your memory for this, or estimate how far you are traveling, you stand a good chance of being lost.

Astronomy is a beautiful study, and aside from the direct bearing it has on our subject, the general information derived from the simple questions involved will be highly beneficial, and is sure to tempt you into further study of it. It is not the place here to dwell upon the whys and proofs of the results we will accomplish; if you want them, and I feel you will if you have never before interested yourself in the subject, secure them from other sources. Neither can the way to use a sextant be dwelt

upon; a few minutes with a "sea-dog" or civil engineer will tell you more than a thousand written words can. Outside of this, I think I can quickly and clearly show how to use the few remaining instruments.

While you are about it, you must learn to locate yourself by day or night, and I am not going to let you off until you know a few stars and are independent of the sun; for instance, it may be cloudy all day or at noon and you miss your location for that day, while the stars, which all astronomers and engineers like best to observe, can be found throughout the night, and in themselves are more accurate, and give best results. When we consider that we can map a place within a half mile out of eight thousand, does that not speak wonders for the results the astronomers have worked out in their tables, and the accuracy of the few instruments used?

And now for the outfit, which either borrow or buy at once, when you will be fully prepared to dive right in and have mastered, by the time you are ready for your trip into unknown regions. And let me say right here, that we will make all our calculations, using nothing but simple arithmetic; a two-minute calculation for latitude and a fifteen-minute calculation for longitude.

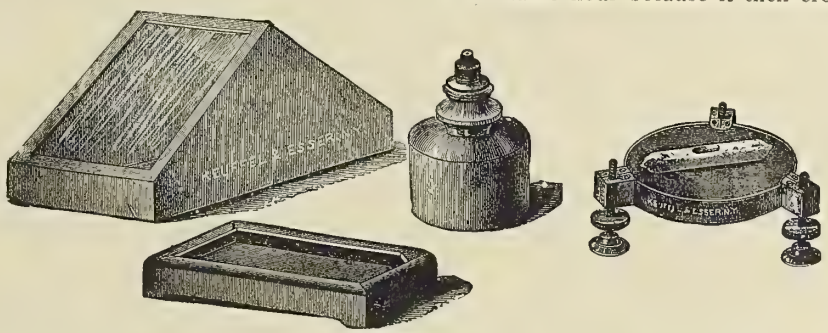


FIG. 2.

INSTRUMENTS.

The Sextant:—Buy the best one you can, but of small size. The Cadet sextant, or one with a six-inch arc, is right; it will cost about sixty-five dollars (£13-7-0) and weigh six and a half pounds. Do not get a larger one, on account of the weight; and it is very slightly, if any, more accurate. It would pay you before buying to have some professor of astronomy examine a few (any first class dealer will allow this), and choose the best. There is always a difference, and his experience and knowledge are better for such a test than your own. Do not buy one of the so-called pocket sextants; you cannot do sufficiently accurate work with them. In the sextant case, you will probably find room to securely fit your small surveying compass, and some tables.

Horizon:—If you leave the sea-shore and explore a short distance inland, you will want an artificial horizon in which to get the reflection of the sun or star (at sea, you use the ocean); and this is either a flat piece of black plate glass with adjustable screws for levelling, or an iron trough to be filled with mercury and inclosed by a glass case to prevent disturbance by the wind; the former weighing a pound and a quarter and the latter, six pounds. They both have advantages and disadvantages. The mercury is automatic, as it were, always making a perfect level end quickly, unless you are in the Arctics, when extreme cold congeals it. It gives a brilliant image, desirable for night work. Any sort of foundation will do, mud, marsh or rock, but it is bulky and heavy. The glass affair costs sixteen dollars (£3-6-0) and is very light and compact, but requires time and care to adjust, and is rather dim for night work. Extreme care must be exercised with the glass horizon, to adjust it with the small spirit level; an immovable rock is about the only thing on which it can be perfectly levelled. Figure 1 shows the ordinary sextant, and figure 2 the two types of artificial horizons, the one, glass with spirit level, and the other, iron bottle, trough and glass cover, describel previously.

Star Map:—Procure a star map of the northern or southern hemisphere as published by the government, from a dealer in nautical instruments, and costing twenty cents (10 d.). If you happen to know one constellation or star, you can find, with the aid of your map, any other. For instance, if you want to find Arcturus (a fine star for longitude in the north), and knowing, as everyone does, the "dipper," you find from the map that it is a bright star almost in line with the handle of the "dipper," and with the map in your hand you can find it in the sky, provided it is above the horizon; if it is not in sight, you must choose another star, or wait; but we will speak of this later. The map shows the brighter stars, and certain tables in the nautical almanac, of which you must get a copy for fifty cents (2/-), tell you the ones to suit for different times of the night; also procure a book of Bowditch's tables, for $1.25 (5/-).

You will know that during the twenty-four hours every star crosses our meridian (which is an imaginary line due north and south overhead), but some stars are called winter and some summer stars, which means that they cross at different times in the night. Vega, the arc-light of the heavens, which is directly overhead at 9 P. M. in August, will be invisible in March at the same hour because it then crosses during daylight. This is caused by the stars moving to the west about four minutes daily, completing the cycle in one year, and of course if we become familiar with stars here and we go much to the north or south, we must learn new ones, but this is easy and interesting. Do not bother with the North star; it is very faint and not truly at the celestial north pole, and can be used only with additional calculations, for our work. It is simply a rough guide for a northerly direction.

Time Piece:—The last but not the least article required is a high grade pocket chronometer or watch. The one that I have used with a great deal of satisfaction was an Elgin, twenty-three jewel, Veritas movement, eighteen size case, especially chosen by the company for uniformity of rate for temperature and position; this cost, in a gold case, eighty-five dollars (£17-10-0). To show what work a watch of this kind will do, let me say that, having had it only a month, before starting on a long trip, I had to let this short time suffice for its becoming accustomed to my always wearing it, and found it to be losing 4.03 seconds a day. During this trip, being constantly on the move, it was impossible to make further tests as to how it was running, and for all observations the above rate was taken. After five months, on arriving at the telegraph, I was surprised to see that the rate had varied from this but a few hundredths of a second a day.

It is highly important, in getting a good movement, to protect it from all jar and sudden changes of temperature; also, to wind it, as nearly as possible, at the same time every day. It does not matter how much the watch loses or gains per day, so long as the rate is uniform. This rate, multiplied by the number of days out, will give the correction required to find the mean time of the meridian on which it was set. Supposing you set the watch on Washington or seventy-fifth meridian time, and, when making an observation for longitude, find the local time; then the difference between the local time at place of observation, and time as shown by the watch, will give you the

longitude, east or west as the case may be, as we will show later.

Longitude depending upon the carrying of some time other than local, you will see that if the watch stops, you are unable to place yourself. Four seconds of time equals about one mile (nautical or geographical) at the equator, so every second counts in this work for longitude, whereas with latitude is is not necessary to have time at all. Do not set or change the rate from the time of first doing so until the finish of your trip. It is only by observing this rule that you can get a line on how the watch is running.

(To be continued.)

four centrifugal pumps, four engine pumps, four steam pumps, and five duplex pumps, which are collectively able to dispose of five thousand tons of water in one hour. Twenty-four bulkhead doors are provided with the Stone-Lloyd patent closing device, which is operated from the bridge. In the chart room on the bridge a plan of the vessel shows by a system of colored lights what watertight doors are closed, and what doors are open.

To guard against the danger of fire, the steamer is equipped with three different fire alarm systems: one leading to the various quarters in which the crew are housed; another one with a complete set of bells for the various other parts of the steamer, and seventeen fire alarm boxes on all decks, from which an alarm

THE NORTH GERMAN LLOYD EXPRESS STEAMSHIP KRONPRINZESSIN CECILIE STEAMING UNDER FULL POWER.

THE NEW NORTH GERMAN LLOYD STEAMSHIP KRONPRINZESSIN CECILIE.

The twin-screw express steamship *Kronprinzessin Cecilie* is a sister vessel of the steamship *Kaiser Wilhelm II,* which was built in 1903, and was constructed in the same yard—that of the "Vulkan" Shipbuilding Company, at Stettin, Germany. The dimensions are: length 706 feet; beam 72 feet, depth 44 feet 2 inches; the displacement 26,000 tons, and the gross registered tonnage nearly 20,000 tons. Her weight on launching was 11,200 tons. The steamer is built of the best German steel, and in accordance wtih the rules and regulations of the highest type classified by the Germanic Lloyd. She is schooner rigged, with three pole masts, and has four large funnels in groups of two.

She has a double bottom, which is divided into twenty-six watertight compartments extending over the entire length of the vessel. Seventeen watertight transverse bulkheads, of which sixteen extend to the upper deck and one to the main deck, and a bulkhead between the starboard and port engine rooms, divide the hull into twenty watertight compartments, of which two adjoining compartments could be filled without affecting the flotation of the vessel. Water entering the hull can be expelled by can be sent. Twenty-eight lifeboats, eight of which are semi-collapsible, are carried on the boat deck, on which four steam winches are located for the purpose of launching them. Each one of the three anchors on the forecastle weighs 15,000 pounds, and the total length of anchor chains is 2,460 feet. The Marconi wireless telegraph is installed on this steamer, rendering it possible to remain in touch with land on one side or the other of the Atlantic during the whole trip across.

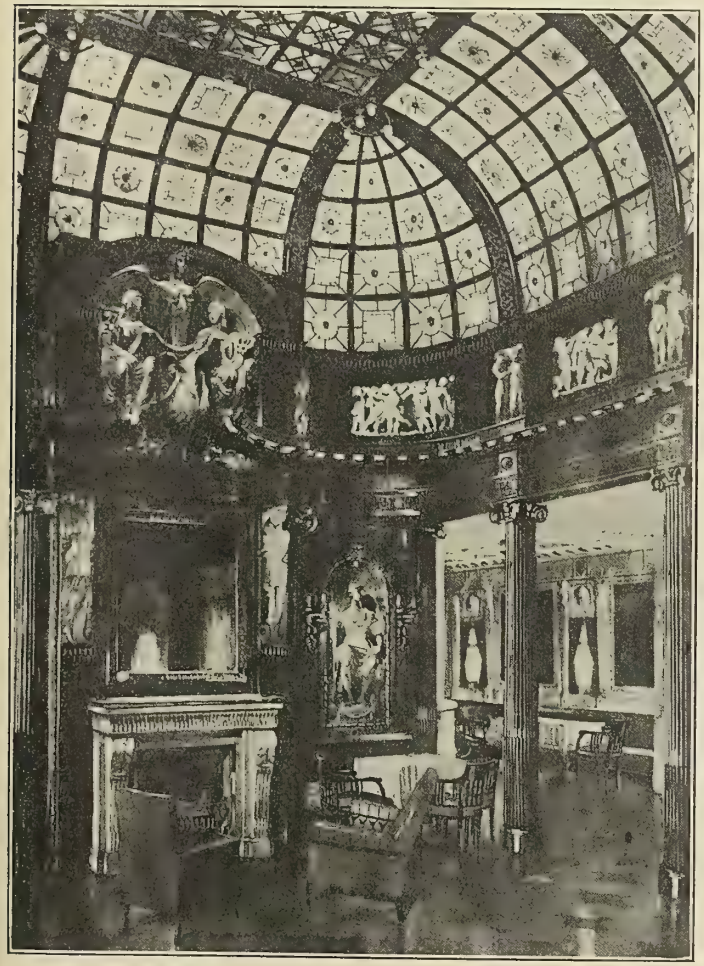
The *Kronprinzessin Cecilie* is provided with four steel decks below the upper deck. Above that deck there is a spar deck running from fore to aft, which serves as a promenade deck. Upon this a midshiphouse is erected, 443 feet in length and 53 feet in breadth, with a deckhouse aft 111 feet in length. Another or upper promenade deck, 535 feet in length, follows above the lower promenade deck; and on this upper promenade deck again there are two deck houses, one 436 feet and the other 26 feet in length. The boat or awning deck extends over these two deck houses to the extent of 451 feet and 59 feet respectively. The construction of the steamer shows, therefore, two comfortable and protected promenade decks on which passengers can sit or walk, sheltered from the weather.

The crew consists of 679 persons, of which twenty-four are officers; sixty-one engineers, oilers and electricians; 231 firemen and coal passers; 229 stewards and stewardesses; 33 pantrymen and scullerymen; 33 cooks, bakers and butchers; 9 barbers, hair dressers, booksellers and baggagemasters; and 59 quartermasters, boatswains, sailmakers and sailors.

The accommodations for passengers consist of 287 rooms in the first cabin, 109 rooms in the second cabin, and seven roomy compartments for the steerage passengers. Quarters are thus provided for 775 first class, 343 second class and 770 steerage passengers, a total of 1,888.

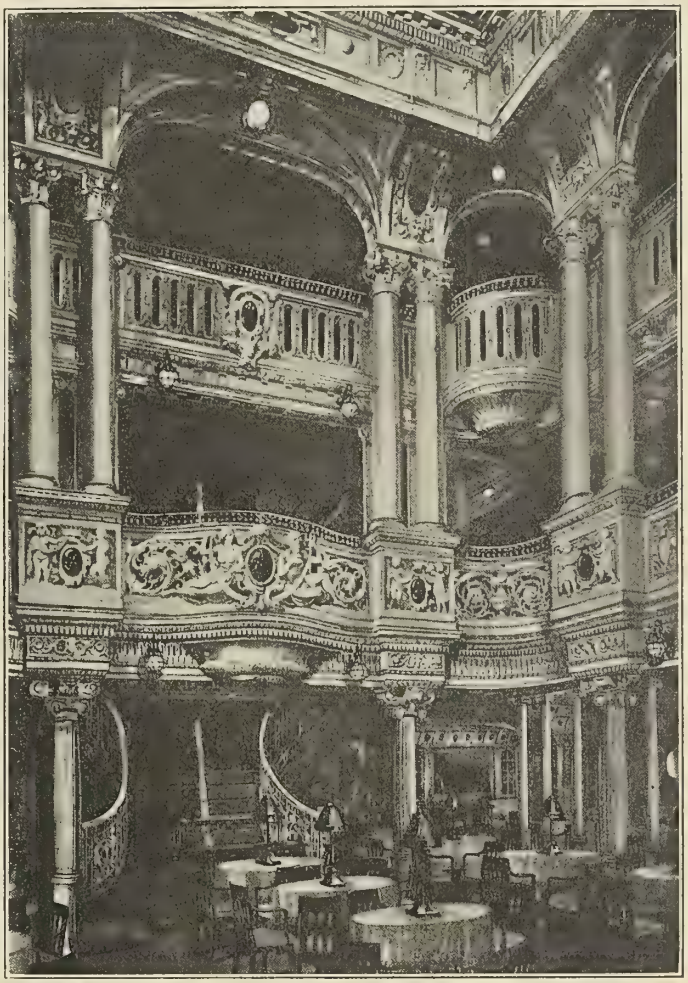
The first cabin rooms are situated upon the upper and lower promenade decks, the upper deck and the main deck; and, besides the regular state rooms, the steamer contains two Imperial suites, consisting of a parlor, dining room, bedroom and bath room with toilet; eight other suites, consisting of parlor, bedroom and bath room with toilet; and twelve cabines de luxe, consisting of large bedroom and adjoining private bath room with toilet. All the regular state rooms, as well as the suites and cabines de luxe, are provided with every luxury and comfort. Many of the rooms are arranged for one passenger only.

The dining saloon is surmounted by a skylight which extends through four decks above, and in the construction of which



THE MANTLE AND SKYLIGHT IN THE SMOKING ROOM.

Florentine Renaissance has been adopted in a white tone, richly covered with ornaments. Sixteen pillars carry a dome with a glass roof, which cuts off the skylight at the drawing room level above the dining room. Behind the pillars, the balustrade of the second deck is visible, projecting in the corners in pulpit form. The carved lower balustrade shows two reclining figures in the middle of each of the four sides, containing the busts of the crown princess and the crown prince, and their coat of arms in bronze relief. The sides of the dining saloon are partly ornamented with paintings showing landscapes, or scenes from Mecklenburg, the home of the crown princess, and covered with blue silk tapestries. The floor is provided with rubber tiling. The afterpart of the room shows a staircase in bronze and wrought iron, which leads to the upper decks. As the skylight is white



A CORNER OF THE MAIN DINING SALOON.

in tone, and the passageways around it on the upper decks are of dark mahogany, the skylight will show very advantageously against the dark background. The dining room contains seventy-six small round tables for two, five, and seven persons, instead of the long tables formerly in use, on which the passengers will be served as in the restaurant of a large hotel on shore,—not at a fixed hour as heretofore, but between certain hours. One can engage a table for his party and select an à la carte dinner, if so desired, without extra charge, instead of the regular table d'hôte dinner,—an innovation which is a great boon to the traveling public.

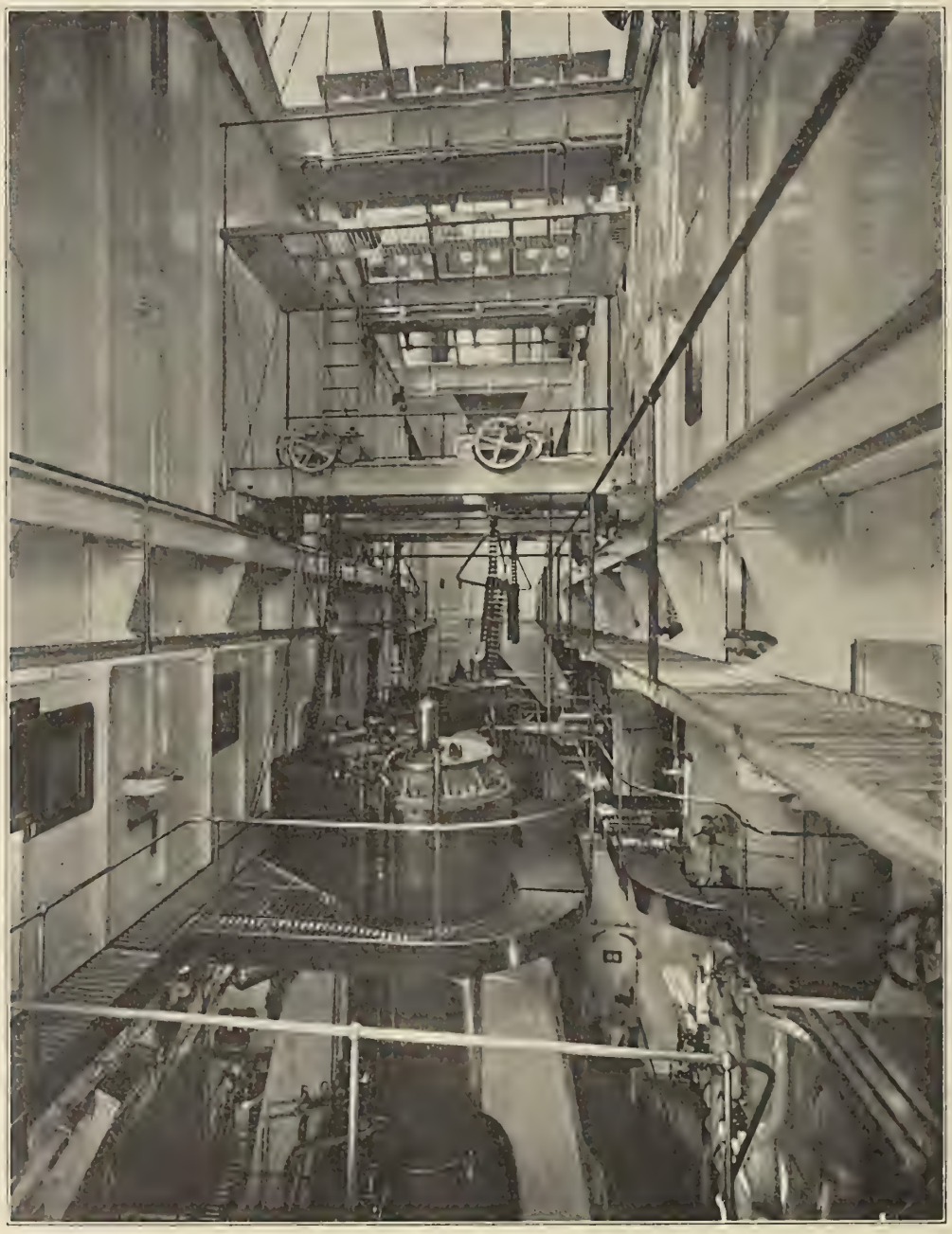
A children's dining room has been provided on the deck above the regular dining room. The lower part of the walls is covered with dark blue tapestry, the upper part showing pictures of scenes from childhood life, together with reliefs from well-known fairy tales.

The smoking room is treated in the modern Roman style with a central dome supporting a glass roof. The larger part of the room is decorated in white, with leather tapestry; the seats, chairs and sofas are covered with greenish-blue leather; the floor with rubber tiles. The pictures show scenes from the home of the crown princess—Mecklenburg.

On the upper promenade deck is situated the music room, decorated in the Empire style, the walls covered with red silk tapestry. Chairs and carpets match this color. The forward wall of the music room contains a life-size oil painting of the

German crown princess. The library and writing room is forward of the music room, and of the same character. The furniture is of old mahogany, covered with blue gobelin, the walls decorated in white.

The arrangement of Vienna cafés, introduced on the *Kaiser Wilhelm II,* has proved to be so popular that it was also adopted on the new steamship, a café for smokers and one for ladies being provided on the awning deck. Besides coffee and liqueurs, pastry, etc., which are served in these Vienna cafés, hot dishes are also obtainable in the café for smokers. This has an open air attachment in which passengers can sit at small tables, enjoying the fresh air and the beautiful view of the sea while taking their coffee. The café for smokers is decorated in Louis Seize style. The walls are in white enamel, the sofas and chairs covered with green peganoid. The sides of the café are divided into niches provided with comfortable sofas, tables and chairs. The afterwall is entirely taken up by a large niche, containing sofa, small tables and chairs. The entrance to this café is by a stairway forward, to the left and right of which are buffets. The café itself is lighted by large square windows and skylights. At night, artificial illumination is provided by a large number of artistic electric lights distributed in the ceiling and in the niches. The outdoor attachment of the smokers' café is decorated in Frisian style; the walls and ceiling in white enamel. Bronze doors with large openings, filled with glass, can be closed in very bad weather, in order to insure complete protection.



THE UPPER PART OF THE SPACIOUS ENGINE ROOM ON THE KRONPRINZESSIN CECILIE.
(Photograph, Byron, New York.)

The ladies' Vienna café is also decorated in the style of Louis Seize. The panels of the wall are of citron wood and are decorated in the style of the boudoir of Queen Marie Antoinette in the palace of Fontainebleau. The windows are hung with green silk curtains, and the chairs are covered with the same material.

Second class passengers are berthed in the after part of the lower, upper and main decks in rooms for two, three and four persons, and are comfortably cared for in a dining room containing 190 seats, a smoking room and a music room on the lower promenade deck.

The captain and officers are berthed in quarters on the bridge deck, immediately under and aft of the bridge. The engineers and the engine force are berthed around and in the immediate neighborhood of the engine room.

The number of bath rooms for the first and second cabins is twenty-eight, not counting the private bath rooms attached to the suites and cabines de luxe. Running warm water is provided in all rooms and bath rooms in the first cabin. A complete telephone line connects the bridge, the engine room and after bridge, the bridge and the look-out on the mast, the captain's room, all of the officers' and chief steward's rooms, and the pantry, and all suites and cabines de luxe.

The culinary arrangements on the *Kronprinzessin Cecilie* correspond in all particulars with the economic departments of a large first class hotel. Each class and the crew have their own large kitchen arrangement. The galleys for first and second class are situated in the neighborhood of the respective dining rooms, and are equipped with an extensive range, with five steam cooking units, with heating arrangements and dressers. The galley of the firemen and coal passers is equipped with four steam cooking units, and that for the third class passengers with five units of this apparatus. Two large double baking ovens and a confectioners' oven are provided in a separate space next to the galley for the first class. The pantries for the first, second and third class are arranged with the latest inventions, such as plate warmers; coffee, tea, milk and chocolate urns; refrigerators; fresh water filters, egg boilers, etc.; besides which there are pantries provided for the smoking rooms of the first and second cabin, the two cafés, and one bar for each smoking room of the first and second cabin, and for the passengers of the third class. In the lower decks provision refrigerators, ice cellars and large provision rooms are situated.

In adopting for the new steamship the old form of reciprocating engines instead of the new turbine type, the managers of the North German Lloyd were actuated by the fact that the turbine is still in its development, whereas the performances of the reciprocating engines are well tried and proved,—the *Kaiser Wilhelm II,* for instance, having made more than forty round trips, without being obliged to stop a single minute on account of her engines. The engines of the *Kronprinzessin Cecilie* develop 45,000 horsepower in four quadruple engines, of which two are installed tandem, one behind the other, on each shaft, with six cranks. Each of these double engines is placed in a separate watertight compartment inclosed by bulkheads in a fore-and-aft direction, as well as transversely. Through the balancing of the engine parts under the Schlick system, the vibrations have been reduced to a minimum.

The total number of cylinders of the four engines is sixteen. The piston stroke is 71 inches, and the diameters of the cylinders 37, 49, 75 and 112 inches, respectively, the high-pressure cylinder being placed above the first intermediate cylinder. The crank shafts are constructed entirely of nickel steel, and have a diameter of 25 inches. The total length of the shafting is 236 feet, with a total weight of 240 tons. The two propellers are provided each with four blades. They are constructed of manganese bronze, the diameter being 24 feet, and the weight 79,200 pounds. The total number of main and auxiliary engines for the various purposes in use on the steamer is seventy-two, with a total of 126 steam cylinders.

The steam for the main and auxiliary engines is produced in nineteen large cylindrical boilers, of which twelve are double-ended and seven single-ended boilers. The diameter of each of the boilers is 17 feet, and the length of a double-ended boiler 20 feet 10 inches. The total number of fires is 124. Eighty-one firemen and coal passers are busy in each watch of four hours. The ventilation for the boiler rooms is furnished by ventilators, assisted by an extensive system of electrically driven fans. The height of each of the four stacks is 121 feet above the grate bars; their diameter is 16 feet 6 inches.

The electrical current for illumination, heating, ventilation and other purposes, is furnished by five dynamos, of which four are situated aft of the main engine rooms between the propeller shafts, and the fifth on the main deck at one side of the engine room. Each of the five dynamos delivers a current of 1,000 amperes at a pressure of 100 volts. The steamer is equipped with 3,100 electric lamps, and with electric bells in all first and second cabin rooms. The smoking rooms and cafés contain electric cigar-lighters, and the state rooms are provided with plugs and connections for ventilating fans and curling irons. All outside rooms, as well as the suites and cabines de luxe, are heated electrically.

The materials used in the construction of this steamer consisted of about 11,000 tons of steel; 700 tons of rivets, bolts and screws; 300 tons of cast and wrought iron; 42,000 cubic feet of teakwood; 70,500 cubic feet of Oregon and pitch pine, and 19,426 cubic feet of pine.

THE SIZE OF BATTLESHIPS AS A FUNCTION OF THEIR SPEED.*

BY J. A. NORMAND.

The Russo-Japanese war, and particularly the naval battle of Tsushima, has revived the discussion of the value of speed for fighting ships. One can hardly say, however, that much light has been shed on the question, since diametrically opposite conclusions have been drawn from the facts.

On the one hand, a reduction of speed allows giving a ship of fixed dimensions greater offensive and defensive power, or, if the latter remain the same, diminishing her size and, in consequence, for the same initial expense, increasing the number of units and putting in the line of battle more gun power. Considerations as to the accessibility of harbors and the utilization of their workshops; of possible employment of old and less speedy units in squadrons without compromising the latter's homogeneousness; of seas or canals in which the squadrons must operate; of the proportions of the engines and of the conditions of installation and service of the magazines, the more favorable as the speed is less, militate in equal degree in favor of low speed.

On the other hand, great speed may be demanded for strategical or tactical reasons. The question cannot be rigorously treated unless we know the law, in accordance with which the absolute size of large fighting ships varies with their speed, when their offensive and defensive powers, as well as their radius of action, remain unchanged. The object of the present note is to find this law.

Let there be a battleship differing little from the English type *Commonwealth,* the last class of which the results of the trials are known.

Total length of hull (L) ..... 138.00 m. (453 ft.)
Maximum width of hull ..... 23.80 m. (78 ft.)
Draft ..... 8.15 m. (26.75 ft.)
Height of upper deck above waterline, at middle of length ..... 6.20 m. (20.3 ft.)
Area of immersed part of midship section (B^2) ..... 180 sq. m. (1,938 sq. ft.)
Displacement with normal coal supply of 1,000 tons (D) ..... 16,600 metric tons (16,350 tons)
Maximum horsepower 18,000
Corresponding speed (V) ..... 19 knots
Weight of propelling machinery complete, with water ..... 1,800 tons

Artillery.—Four 30.5-cm. (12-inch), four 23.4-cm. (9.2-inch), ten 15.2-cm. (6-inch), fourteen 7.5-cm. (3-inch), fourteen 4.7-cm. (3-pounders). This battery, which is that of the *Commonwealth,* appears to comprise too many different calibers, but the weight which it represents is about that of the most modern armament of a ship of this kind.

Protection.—This consists of an exterior belt, rising in the central part to the upper deck, and of 23 cm. (9 inches) thickness

* Proceedings of the United States Naval Institute.

at the waterline, diminishing to 16 cm. (6¼ inches) at the upper deck. The protection of the ends is weak, especially at the stern.

Let us first determine what increase of available displacement would be given by a reduction in speed of one knot.

This increase is made up of three principal items:

1. THE INCREASE OF DISPLACEMENT RESULTING FROM DIMINUTION OF FINENESS OF LINES.

Considering the formula for maximum normal speed*

$$V = 1.4 \frac{1.026\ B^2L - D}{1.026\ B^2} B^{\frac{1}{2}}.$$

We see that this speed is proportional to the fineness of lines (sharpness), a fractional term, and to the square root of the linear dimensions ($B^{\frac{1}{2}}$), according to the law of Reech and Froude. It has been shown, in the table annexed to the note cited,* that the speeds thus calculated approach closely the maximum speeds realized, or, at least, that they sensibly follow the same law of variation; the formula, therefore, appears to conform both to theory and to practice. The coefficient 1.4 is a mean value.

Let us calculate, for a large ship which has realized a maximum speed V, the coefficient K such that

$$V = K \frac{1.026\ B^2L - D}{1.026\ B^3} B^{\frac{1}{2}}. \qquad (1)$$

We have a right to assume that, if we reduce the speed of this typeship by one knot, B^2 and L remaining the same (such are the conditions of our problem), and make the displacement D vary so that K retains the same value, the "coefficient of propulsion" will not vary; in the two cases the water will be displaced in equal times.

Formula (1), differentiated with reference to V and D, the only variables, gives

$$\frac{dD}{dV} = \frac{1}{K} \frac{1.026\ B^3}{B},$$

or, replacing B^1 by its value from (1), and noting that, the above coefficient being constant, the differentials may be replaced by finite differences,

$$\frac{\triangle D}{\triangle V} = -\frac{1.026\ B^2L - D}{V}. \qquad (2)$$

From the elements of the battleship type given above, we find for K the value 1.446, which corresponds to great fineness of lines for such a ship, and formula (2) then gives for $\triangle V = -1$,

$$\triangle D = 468 \text{ tons}.$$

The surface, and consequently the weight, of the hull being slightly increased, we will take as the available increase only 450 tons, or, 2.7 percent of the original displacement.

For $\triangle V = +1$, that is to say, for an increase instead of a decrease of one knot in the speed, the change of displacement is negative and equal to — 450 tons. On account of the necessary increase of fineness, there results a deficiency of displacement of 450 tons.

2. THE DIMINUTION OF WEIGHT DUE TO REDUCED POWER.

The fineness of lines being modified to correspond to the reduced speed, and the two other principal elements of the resistance, area of midship section and surface of hull (the latter is not materially increased) remaining the same, it is very probable that the "coefficient of propulsion" does not vary, and that the powers are proportional to the cubes of the speeds, or, for a reduction of one knot, as

$$\left(\frac{18}{19}\right)^3 = 0.850.$$

If the weight of the propelling apparatus varies as the power, the reduction would be $(1 - 0.850)\ 1800 = 270$ tons. This is very nearly the case for the boilers and condensers; the stacks are, it is true, heavier per horsepower, but the relative weight of the tubing is less, and the fuel handling requires a smaller personnel, all proportions considered.

For the machinery, on the contrary, not only does the length of the lines of shafting not change, but, as M. Durand-Viel has shown in a remarkable memoir which has just appeared in the *Revue Maritime*, for the same ratio of pitch to diameter and the same value of the coefficient of propulsive surface j, the weight of the machinery (about half that of the whole propelling apparatus) varies as $V^{5/2}$ instead of V^3.

The relative weight of the less powerful propelling apparatus complete is then about

$$\tfrac{1}{2}\left\{\left(\frac{18}{19}\right)^3 + \left(\frac{18}{19}\right)^{\frac{5}{2}}\right\} = \tfrac{1}{2}\,(0.850 + 0.875) = 0.8625$$

and the reduction of weight is

$$(1 - 0.8625)\ 1800 = 250 \text{ tons}.$$

This reduction of weight changes to an increase if the speed of the battleship type, instead of being diminished from 19 to 18 knots, is raised from 19 to 20 knots. It is interesting to note that the less powerful machinery works under better practical conditions, and will more easily maintain its full power.

M. Durand-Viel shows, as a matter of fact, in the memoir already referred to, that, for the same ratio of pitch to diameter and the same value of the coefficient j, the ratio of the linear dimensions of the engines to those of the hull is independent of the displacement, and varies as $V^{5/6}$, that is, almost as the speed. Either the stroke is kept the same, which is possible since the dimensions of the hull remain unchanged, and the cylinder diameters are diminished, or the piston speeds are notably reduced.

3. THE REDUCTION IN WEIGHT OF THE UPPER WORKS.

It is difficult to accurately estimate this saving, although it undoubtedly occurs; a ship hindered by a seaway behaves better, and is less wet, when her speed is reduced. The course which makes speed less than the maximum necessary, either to keep the sea without exhaustion or to use the guns, is principally that on which the ship receives the waves from forward or on the bow, the time occupied in rising from the hollow to the crest of the wave being then inversely proportional to the ship's speed increased by the speed of the wave. The most unfavorable sea is that producing short waves, consequently of low speed, such as those of the Mediterranean.

Let 15 knots be the speed of the waves; it may be assumed that the conditions of navigability will be the same for the battleship of eighteen knots and the one of nineteen knots, when, the underwater bodies being the same, the heights of the upper works are in the ratio

$$\frac{18 + 15}{19 + 15} = 0.9706.$$

The height of the upper decks above the waterline at middle length, which is 6.20 meters (20.3 feet) in the typeship, can therefore be lowered $(1 - 0.9706)\ 6.2 = 0.183$ meter (7.2 inches).

The thickness of the outer armor plating being 16 cm. (6.4 inches) at its upper part corresponds approximately, taken together with the side supporting it, to 22 cm. (8.66 inches) of steel, and its total length on the two sides and the transverse bulkheads is 184 meters (604 feet). This length may without exaggeration be taken as of 22 cm. thickness, taking account of the considerable excess thickness of the turret supports and of the various armored passages whose heights are simultaneously diminished. The saving of weight then would amount to

$$220 \times 0.183 \times 0.22 \times 7.8 \text{ tons} = 69.2 \text{ tons}.$$

This reduction of 0.183 meter in the height of the upper works does not seem excessive, when it is remembered that there are battleships whose freeboards are much less than that of our typeship, the *Hood* for example—a rather poor seaboat, it is true—of 14,400 tons and 17½ knots, whose freeboard forward is less than 4 meters (13.1 feet), an amount at least 2.2 meters (7.2 feet) less than that of the typeship.

* Approximate rules for the calculation of the propulsive surface (*Bulletin de L'Association Technique Maritime*, 1899, page 7).

The reduction of 0.183 meter per knot, supposed constant, corresponds, therefore, to a reduction in speed of the typeship of from 10 to 12 knots in order that she may find herself in the same condition as the *Hood* in the matter of the height of upper works. The height of the guns ought, it is true, to remain such that their fire shall not be interfered with by the waves under any condition of the sea which would permit fighting; that of our type battleship, 8.5 meters (27.9 feet) would appear to allow of reduction. Moreover, the height of turret guns can be maintained even while that of the upper works of the ship is reduced; the saving of weight would still be considerable, and the stresses on the deck due to firing the guns would be diminished.

We will take no account of the saving of weight which the space made available by the reduction of the propelling machinery would enable us to make in the superstructures, which we will assume to be reduced to a minimum, as they should be. So, too, we will merely note the reduction of the personnel of the motive power. It is clear that an increase instead of a reduction of speed of one knot would merely change the sign of the corresponding change of weight.

To sum up, the reduction of the speed of the type battleship from 19 to 18 knots would furnish an increase of displacement of 450 tons and a saving of weight of 250 + 69 = 319 tons, or a total availability of 769 tons (4.63 percent of the initial displacement), which can be used to increase either the protection, the artillery, or the radius of action, the ship retaining meanwhile the same draft, length and beam, and remaining equally seaworthy. The displacement, which was 16,500, would become 17,050 tons.

The availability of 769 tons may be otherwise employed: it may be utilized to reduce the size of a ship. It is known, as a matter of fact, that any saving of weight $\triangle\pi$ realized on a ship, permits reducing her displacement, by an actual decrease of size, by an amount $K'\triangle\pi$ notably greater than $\triangle\pi$, the speed, radius of action, seaworthiness, protection and offensive power remaining the same. If $\triangle\pi$ represents an addition instead of a saving of weight, it is necessary, on the contrary, to increase the displacement, by making the dimensions bigger, by the same quantity $K'\triangle\pi$.

The coefficient K' varies according to the type of ship. It is approximately equal to

$$\frac{\triangle D}{\triangle \pi} = \frac{3}{1 - a + \frac{2P}{D}}$$

in which a represents the fraction of the total displacement taken up by the weight of the hull and equipment, without armor, artillery, ammunition or stores, and P is the fixed weight of artillery, turrets, ammunition and stores, but not the hull armor, which latter varies with the hull surface. Whether we use this formula which I gave in 1885, or the slightly modified ones which have been proposed since then, it will be found that, for battleships of the type considered, the value of K' differs little from 2½.

If then the available 769 tons be applied to reduce the actual size of the ship, the displacement will be diminished by

$$769 \times 2.5 = 1{,}922 \text{ tons}$$

and will become

$$16{,}600 + 450 - 1{,}922 = 15{,}128 \text{ tons.}$$

For a reduction in speed of two knots instead of one, the displacement, at 17 knots instead of 19 knots, would be about

$$16{,}600 + 450 \times 2 - 1{,}922 \times 2 = 13{,}656 \text{ tons.}$$

This figure is too low and ought to be taken rather at 13,800 tons, for the variations corresponding to two knots' difference of speed are too great to be calculated exactly by the differential coefficient method; moreover, it is necessary to take account of the fact that the fineness of line of the hull ought to be slightly increased for an equal speed with less actual size.

Thus we see that, if the preceding calculations are correct, in taking as unity the displacement of a battleship of 16,600 tons, 18,000 horsepower and 19 knots, the displacements of similar ships having equal offensive and defensive powers, the same radius of action, and the same seaworthiness, and differing only in speed, are approximately at 17 knots, 0.83; at 18 knots, 0.91; at 19 knots, 1.00; at 20 knots, 1.10; and at 21 knots, 1.20. At 17 knots the displacement would be about 13,800 tons, and at 21 knots about 20,000 tons.

Since the draft of large battleships cannot without much inconvenience be increased, and since the vertical space available for the machinery is sensibly constant, it will be seen that the proportions of the latter, supposed to be of the reciprocating type, become more and more defective as speed is increased. From this point of view, steam turbines have a serious advantage.

The comparison of the battleships of *Kansas* type and those of *Idaho* type now being built for the United States navy seems to confirm the above calculated results. The very powerful artillery and the protection are almost identical in the two cases, but the displacements are 16,000 and 13,000 tons, and the horsepowers 16,500 and 10,000, respectively.

These ships not being yet delivered, their speeds are not exactly known, but admitting an equal propulsive efficiency for the two types, we find that for 18.5 knots, the speed of the *Kansas*, the *Idaho* should attain 16.5. To this difference of two knots corresponds a ratio of displacements equal to 0.814. This result agrees with the practical rule given above.

The maritime world is greatly preoccupied with the *Dreadnought*. Whatever may be the differences, still very imperfectly known, between this battleship, celebrated before being born, and the most powerful ships of recent construction, in artillery, protection and motive power, there ought not to result therefrom any change in the formula given above. The constants will merely have to be more or less modified.

I am first to recognize that in these calculations a large part is hypothetical. The problem of which I have attempted to give an approximate solution is of great interest, and merits a more complete study.

COMMENTS.

BY NAVAL CONSTRUCTOR D. W. TAYLOR, UNITED STATES NAVY.

This very interesting and suggestive article by the late M. Normand bears upon one of the questions in naval architecture which is just now of vital interest. M. Normand has taken the published data for an actual ship and developed an approximate formula for the purpose of determining the displacement and power of ships of the same midship section and length, but greater and less displacements with less and greater speeds. This falls into a class of problems which can be dealt with very directly by model basin experiments, and I will indicate the solution of this particular problem, which we obtain from our accumulated data.

We are not able to take up the investigation with knowledge of the actual lines of the *Commonwealth*, but it happens that we have run at the model basin a series of models of ratio of beam to draft very close to that of the *Commonwealth*, and varying in fullness and displacement. From the results of this series we can determine the effective horsepower for any model within limits upon the parent lines of any size and fullness. To connect this result with the *Commonwealth* data it is necessary simply to assume an efficiency of propulsion (which happens to be a little over 50 percent) which will give our ship derived from the series lines, and having the same midship section area and fineness as the *Commonwealth*, a speed of 19 knots upon 18,000 horsepower. Applying this efficiency of propulsion to the curves of effective horsepower, we are enabled to readily produce the curves of estimated indicated horsepower for vessels 452.8 feet long, with 1,938 square feet area of midship section, and of displacement ranging from 15,500 to 17,500 tons, for speeds ranging between 15 and 20 knots. While the figure applies directly to vessels upon the parent lines of the series used, it will represent with very good approximation the nature of the variation of vessels upon other lines. The efficiency of propulsion

used is rather low than otherwise, and it is reasonable to suppose that the lines of the series used would drive very much the same as those of the *Commonwealth*.

Comparing the figure with M. Normand's results, it is seen that the latter has, if anything, understated the case as regards the saving of weight and reduction of speed. He estimates at 15 percent the reduction of power for a vessel of 17,050 tons and 18 knots speed, making the actual power as thus estimated 15,300. From the curves the power for a vessel of 17,000 tons would be about 13,600, or a reduction of nearly 25 percent. This would make the reduction in machinery weight over 400 tons, instead of the 250 tons as estimated by M. Normand, and would make his available displacement due to the change of speed and fullness over 850 tons instead of 769, without allowing anything for the reduction in weight of the upper works, which would be somewhat problematical. On the increase side M. Normand's formula would underestimate the extra weight necessary to put into machinery, even more than it underestimates the saving on the side of decreased speed. It would seem then that, for the particular case in hand, his formula is very conservative as regards the influence of speed upon available displacements, and that the saving through reduced speed will be in some cases somewhat greater than he indicates.

In this connection attention may be called to the great influence of fineness upon vessels of the dimensions of the *Commonwealth* when pushed to top speed. The upper curve refers to a vessel of the *Commonwealth* length, of 17,500 tons displacement, while the lower curve refers to a vessel of the same dimensions and of 15,500 tons displacement. This increase of 2,000 tons is a little under 13 percent figured on the 15,500 tons, and the cylindrical coefficient increases from 0.618 for the smallest vessel to 0.698 for the largest one. At 16 knots the corresponding increase in indicated horsepower is about 14.5 percent, figured on the power of the smallest vessel, or almost in proportion to the increase of displacement. At 17 knots the increase of power from the smallest to the largest vessel is 17.5 percent. This percentage shows again a moderate rise at 18 knots to 21¾ percent. At 19 knots there has been a rapid increase to 37 percent, and at 20 knots this increase of 13 percent in displacement upon the same dimensions involves an increase of 57 percent in power. Nineteen knots is about the extreme limit of economical speed for a vessel 450 feet long, and if such a vessel is to be pushed to a higher speed it is necessary to fine her radically.

The connection between speed and length is very important. Reduction of speed allows length, which is the most objectionable dimension of a man-of-war, to be reduced, as a rule, more than in proportion to the reduction of displacement. Thus, in the case of the *Kansas* and *Idaho*, referred to by M. Normand, the displacements are in the ratio of $\frac{13}{16}$, or 0.8125. If all dimensions were reduced similarly to produce this reduction in displacement, the reduction would be in the ratio 0.933, which would make the length of the *Idaho* about 420 feet. As a matter of fact, the *Idaho* could be, and was, reduced in length to 375 feet without exceeding at 17 knots the limit for economical propulsion, and this reduction in length, an indirect result of the reduction in speed, was a very powerful factor in enabling the offensive and defensive power of the *Idaho* to compare so favorably with those of the vessel of nearly 25 percent more displacement.

It may be noticed that the figure illustrates the fact, that for vessels of the type under consideration the relative importance of fineness as regards speed increases rapidly with the speed. This fact has a very important result upon the dimensions of high speed battleships. As a practical proposition, we cannot afford to make these vessels much longer than is necessary to carry their battery and machinery. Greater length would help somewhat as regards speed, but is forbidden by considerations of protection, handiness, and target area. We must gain speed by adopting the best possible lines and a fineness best adapted to the necessary and unavoidable length and the required speed. This means in practice greater fineness for high speed battleships. Now, with length and displacement fixed, we can gain fineness only by increase of beam or draft. For the near future the easiest and most obvious change is to increase draft. It is to be hoped that the apparently inevitable increase of size and speed of battleships will not compel the naval architect a few years from now to make radical increases of breadth. Already dock entrances 100 feet wide look rather narrow for the most recent battleships building and designed. The present type of battleship is probably threatened to-day more than at any period of its existence by the submarine. If it survives the competition and is still the dominant type fifteen or twenty years from now, it seems to me quite probable that its maximum breadth will be found 50 percent greater than at the present day—say 120 feet—unless considerations of sizes of docks and locks restrict the designers of the future.

Editor's Note.—In this connection the paper of Commander William Hovgaard before the Bordeaux Congress of Naval Architecture is of interest. His subject was—

THE SPEED OF BATTLESHIPS.

He said, in part: It is admitted that the means and methods by which a speed increase can be realized are well known to every naval architect, and the author is conscious of not being able to offer anything new in this respect. In general, however, a speed increase can be realized only by the simultaneous combination of several features, rendering it difficult to appreciate exactly how the result can best be brought about. It is hoped, therefore, that an attempt by an analysis to disentangle these features, and to evaluate each of them, may be of interest.

The first and most obvious means of increasing speed is by an increase in the percentage weight of displacement allotted to machinery, preserving form and size of ship unaltered. Such increase cannot, however, in general, be effected without a corresponding reduction in the percentages allotted to the offensive and defensive qualities. The question of percentages is indeed primarily a military one, involving, as it does, the question of balance between gun power, protection and speed. Any move in direction of increased machinery percentage means a step in the direction of changing the battleship to a cruiser, but a discussion of this question is considered outside the scope of this paper.

In spite of the great changes in absolute value of the elements, gun power, protection and speed, which have been brought about by technical progress, we find that the percentage weight of machinery has varied but little in battleships during the period extending from the abandonment of sail power to the present time. Although the speed during that period, which covers the last thirty years, has risen from fourteen to nineteen knots or more, this percentage has ranged between ten and twelve, only occasionally or for certain navies passing beyond these limits.

IMPROVEMENTS IN PROPULSIVE MACHINERY.

Computing the savings in weight due to the different improvements here discussed, and disregarding those sources of gain which do not permit of evaluation, we arrive at the following result:—By the use of turbine machinery we may reduce the weight of the boiler plant to about 85 percent of its value for reciprocating engines; by the use of small tube boilers this percentage may be further reduced to about 64 percent, and the total machinery weight may therefore approximately be reduced to 81 percent of its value with reciprocating engines and large tube boilers. Or we may say that on a given weight of machinery we may increase the power by about 24 percent.

By the exclusive use of oil fuel there might be saved about 20 percent on the weight of fuel, equivalent to at least 10 percent of the weight of the machinery, by which amount the power might be further increased. Thus, by a combination of all three features we might expect to increase the power by about 34 percent on the same total weight of machinery and fuel.

WAYS OF INCREASING SPEED.

Assuming that the percentages allotted to the different elements of the battleship—hull, armament, armor, and more espe-

cially machinery with fuel—remain essentially unaltered, it has been shown that the following ways of increasing speed are open to the designer:—

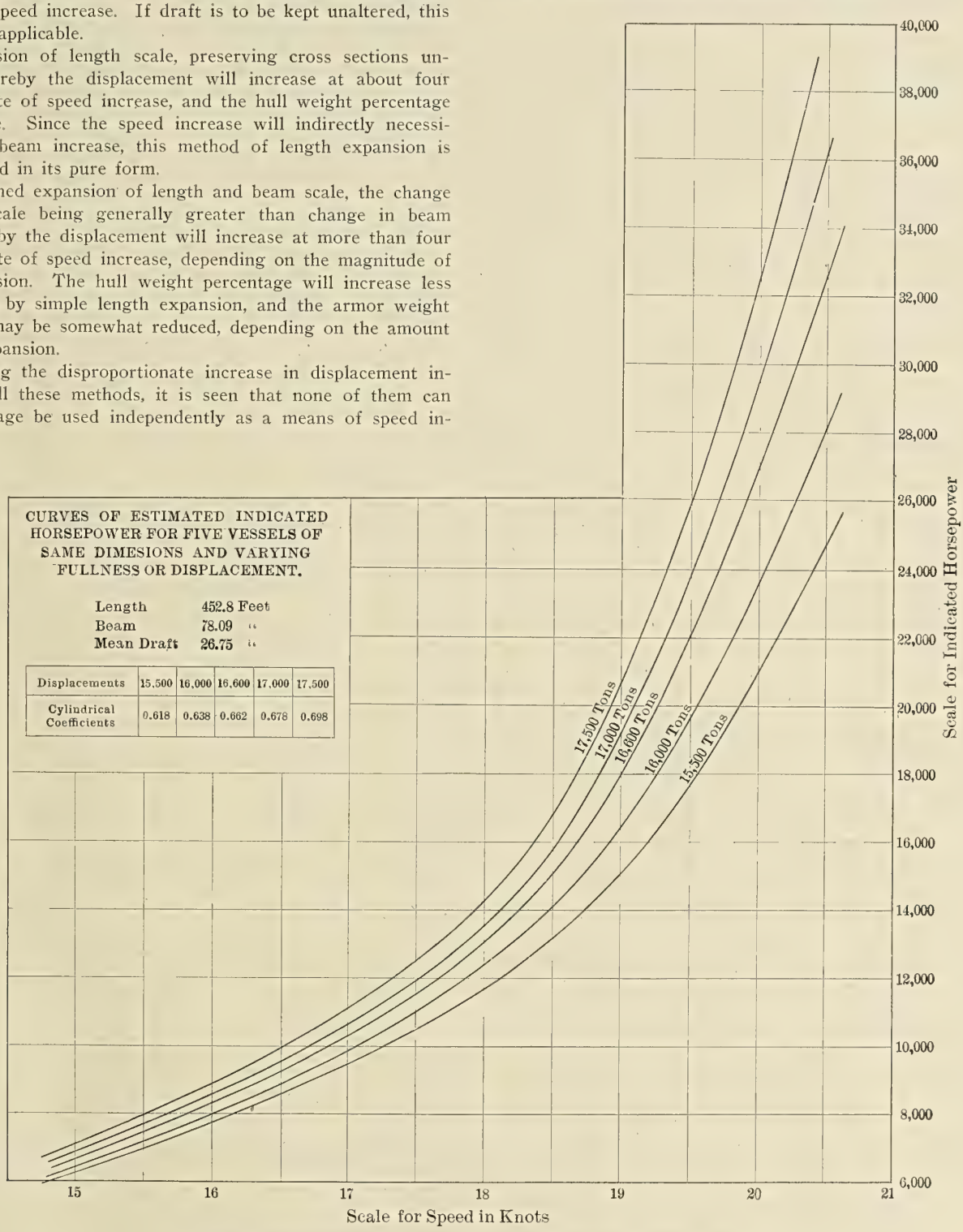
1. Simple increase in size, preserving geometrical similarity, whereby the displacement will increase at about six times the rate of the speed increase. If draft is to be kept unaltered, this method is inapplicable.

2. Expansion of length scale, preserving cross sections unaltered, whereby the displacement will increase at about four times the rate of speed increase, and the hull weight percentage will increase. Since the speed increase will indirectly necessitate also a beam increase, this method of length expansion is rarely applied in its pure form.

3. Combined expansion of length and beam scale, the change in length scale being generally greater than change in beam scale. Hereby the displacement will increase at more than four times the rate of speed increase, depending on the magnitude of beam expansion. The hull weight percentage will increase less rapidly than by simple length expansion, and the armor weight percentage may be somewhat reduced, depending on the amount of beam expansion.

Considering the disproportionate increase in displacement incurred by all these methods, it is seen that none of them can with advantage be used independently as a means of speed increase.

given weight of machinery and fuel. When such improvements are made we must, however, in order to derive full benefit from the increased power, make changes in the form of hull, involving primarily an increase in length and fineness. These changes should be accompanied by an increase in beam.



CURVES RESULTING FROM EXPERIMENTS AT THE WASHINGTON MODEL BASIN.

4. By making the ship finer we shall obtain smaller resistance and require smaller length on a given speed and displacement, but we shall unavoidably increase both the percentages of hull and armor weight. These increases will be relatively so great that this method cannot in a battleship be applied by itself.

5. There thus remains, as the only legitimate method of obtaining a considerable speed increase, the introduction of technical improvements, which permit greater power to be developed on a

At Tsushima the battleships of the Russian main squadron were nominally of the same speed as those of the Japanese fleet. In spite of this, all accounts go to prove that the speed of the Russian fleet was during the battle greatly inferior to that of the Japanese.

While, therefore, on the one hand, this action showed the great value of high speed, it on the other hand demonstrated how unreliable the quality of speed is, and hence how unwise it

is to make great sacrifices in other elements for an increase of a few knots on trial. It appears, therefore, inadvisable to increase the speed of battleships beyond that which can be attained without encroachment on other qualities of the design, i. e., without increase in the percentage weight normally devoted to machinery; but full use should, on the other hand, be made of the available means of technical improvements in machinery.

The Centenary of Steam Navigation.

Although many experiments, with greater or less success, had been made along the general line of the steam propulsion of vessels before the matter was taken up by Robert Fulton, he is generally credited with having invented the steamboat, although as a matter of fact the actual reason for remembering him in this connection lies in his having been the first to have made a commercial success of the proposition. In this connection the following detailed account of a spectacle presented in New York harbor in June, 1813, and drawn from a book published about that time, will be of interest:

DISPLAYED at once IN THE HUDSON

9 Steamboats opposite the foot of Cortlandt Street

"And, while adverting to steamboats, I cannot deny myself the pleasure to notice a recent display of a fleet of them in New York. In June, 1813, nine were displayed at once in the Hudson, opposite the foot of Cortlandt Street, viz: the *Robert Fulton,* two for the East River, one for the Potomac, one for James River, Virginia, two Powles-Hook ferry-boats, one Hoboken ferry-boat, and Governor Ogden's boat from Elizabethtown. The navigation of the harbor by three steam ferry-boats is a circumstance of no trifling importance, as it adds much to the dispatch, certainty and security of the principal ferries connected with the city.

"*Fulton's Steam Ferry-Boat.*—This excellent machine, consisting of a boat with two hulls, connected by a single platform, with a wheel in the space between them and rudder at each end, built for the conveyance of passengers across the Hudson, between this city and the city of Jersey, has got into successful operation, and promises extraordinary facilities for traveling. Horses and wagons stand on each side of the machinery, driving in at one end from a floating bridge fitted to the boat, and out at the other, without raising or descending six inches in accomplishing the passage from street to street on each side of the river. The boat is constructed with both ends alike, and never turns in sailing, but goes back and forth by changing the motion of the wheel. A corps of flying artillery crossed in the boat from Paulus-Hook to this City, on its way to Albany, in four trips, on the first of which it brought four pieces of artillery (6-pounders) and limbers, four ammunition waggons, 27 horses, and 40 soldiers, besides other passengers.

"We must not forget the elegant conveniences afforded by steam navigation on the Hudson. There are now three steamboats employed on this river, between Albany and New York (the largest of which is 170 feet long and 28 wide, its burthen 350 tons), which perform their passages to Albany (150 miles) in the average time of 30 to 36 hours. Their periods are very regular and uniform, and they have excellent accommodations, being designed for passengers exclusively. And, independent of the novelty and ingenuity of the mode, unknown in Europe, the dispatch, certainty of time and entire security, with the perfect conveniency and ease with which we pass so rapidly from place to place, we enjoy the proud reflection that the invention is American; and that no other portion of the world enjoys such facilities of intercourse.

"These river steamboats leave Albany on stated days, one on each Wednesday, Saturday and Monday, at 9 o'clock, A. M.; and New York every succeeding Saturday, Tuesday and Thursday, at 5 o'clock, P. M., in the same order. Passage and board, 7 dollars each way.

"Could the bold and intrepid Hudson have known what two centuries would produce on the newly discovered waters which his little boat first explored in 1608, how would his heart have glowed with great emotions!"

August 11, 1907, is the centennial anniversary of the public trial of Fulton's steamboat, and this date makes interesting the above extracts taken from a copy of Spafford's Gazetteer of New York, 1813, which was found in a second-hand bookstore in Chicago. A brief review of the incidents connected with Fulton's difficulties and final success are timely, since they are not nearly so well known as the latest achievements in steam navigation, which are widely heralded in the technical and daily papers.

The first claim to having propelled a ship by steam was in 1543, by Blasco de Gary, a Spaniard, in Barcelona harbor. The first authentic steamboat was tried in 1707 by Papin. In 1736, Jonathan Hulls patented a marine engine, using belts to a stern paddle wheel. Small gasoline oyster boats in New Orleans harbor are operated this way at the present time.

William Henry, in 1763, tried a model steamboat on the Conestoga River, Penn., near Fulton's birthplace, and it is surmised that Fulton knew of this experiment. Marquis de Jouffroy experimented from 1774 to 1783 with a paddlewheel boat, 40 feet long, but the French government would not grant him a patent.

John Fitch, of Philadelphia, designed a steamboat in 1785. He secured exclusive steam navigation privileges from the Legislatures of Pennsylvania, New York and Delaware before April, 1787, and tried a boat in August, 1787, that was deficient in speed. In 1788, a new boat, with the same machinery, made several trips between Philadelphia and Burlington at a speed of 4 miles per hour, using a 12-inch cylinder. In 1790, Fitch used an 18-inch diameter cylinder, and ran a passenger boat on the Delaware all that summer, running about 2,000 miles, it is said, and a speed of 7½ miles an hour was attained. Fitch's stockholders wanted dividends, not success, and refused to advance more money for more boats. Fitch used oars at the sides of the boats, and in 1796 used something like a screw propeller. He died in 1798.

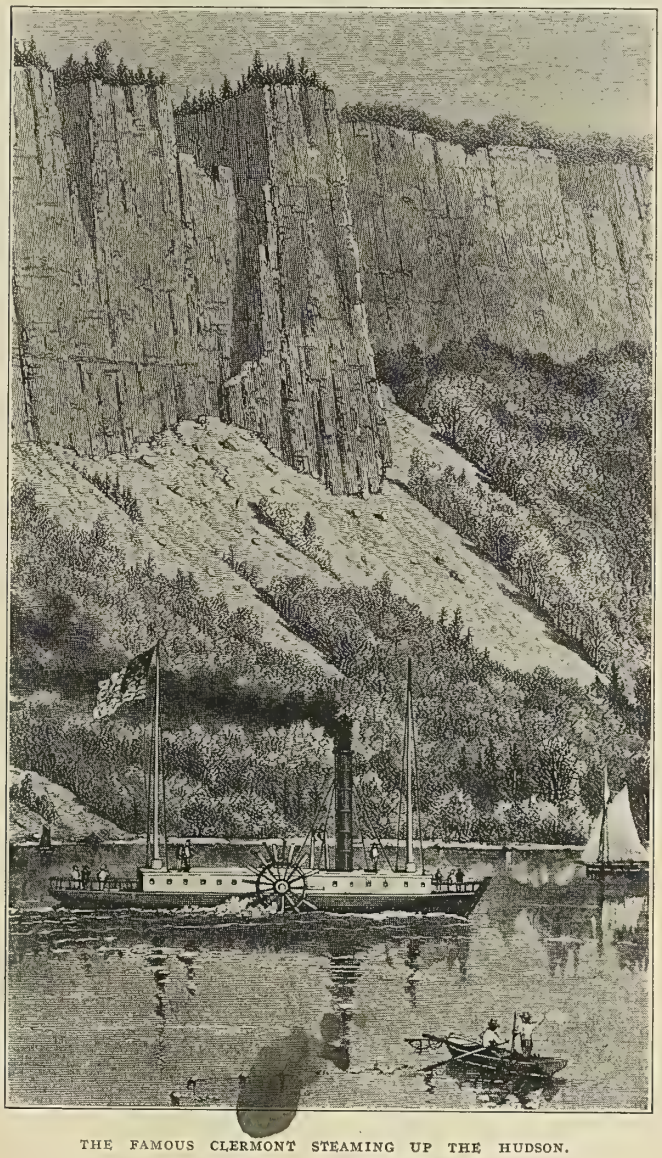
Nathan Read, 1789, used a paddle-wheel steamboat at Danvers, Mass. William Longstreet, of New Jersey, on the Savannah River, in 1790; Elijah Ormsbee, of Connecticut, in 1792; Samuel Morey, of Connecticut, in 1794; Nicholas J. Roosevelt, of New Jersey, in 1798; Miller, Taylor and Symington, of Scotland, in 1788, also made trips on boats propelled by steam in various ways. Col. John Stevens' twin-screw steamer of 1804 was a serious proposition, as noted later, for Fulton and his associates. Livingston, Stevens and Roosevelt worked together in 1798-1800.

The history of the experiments of those who were associated in the commercial success of steam navigation is briefly as follows:—In March, 1798, the year that Fitch died, Robert R. Livingston secured a monopoly of steam navigation in the waters of New York for twenty years, the bill being introduced by Dr. Mitchell, of New York. Immediately after the act was passed, Livingston built a boat of about 30 tons, but it was deficient in speed. He did nothing more until Fulton became associated with him. Fulton, in 1801, built a submarine boat in France with which he traveled 500 yards under water, made a turn, returned to nearly the spot he started, and remained, with a crew of three, 25 feet beneath the surface for 4 hours and 20 minutes. In 1803, he and Livingston built a steamboat at Paris. The weight of the engine broke the boat in two. Another boat, 66 feet long, 8 feet beam, was built and tried, but speed was deficient.

The experiments were then transferred to America and the *Clermont,* of 160 tons, 130 feet long, 16½ feet beam and 4 feet deep, was built at the shipyard of Charles Brown on the East river, New York. The engine, built in England by Watt, had a cylinder 24 inches diameter and 48 inches stroke. The boiler

was 20 feet long, 8 feet wide and 7 feet deep. The paddle wheels were 15 feet diameter, with floats 4 feet long and 2 feet deep. Fulton preferred to try his new boat quietly, so early one August morning, in 1807, before others were out of bed, the *Clermont* steamed from the shipyard over to the Jersey shore. Great excitement was caused among the sailors in the harbor, however, and they regarded the new craft with superstitious dread.

A day or two after the trip to Jersey, a public trial was announced. After this trial, Fulton, observant always, changed the brackets on the paddle-wheels, making them dip less deeply, and



THE FAMOUS CLERMONT STEAMING UP THE HUDSON.
(Courtesy, The New York Herald.)

a subsequent trip showed an increased speed. After this trial the trip to Albany was advertised, and the preponderance of evidence fixes the date as August 11, 1807. The trip to Albany took 32 hours, and the return trip 30 hours. The first important improvements of record were made in 1826, and the time was reduced to 15 hours.

In 1836, the *North American* made a trip in 10 hrs. 20 mins.
" 1840, the *Albany* " " " " 8 " 27 "
" 1841, the *South American* " " " " 7 " 28 "
" 1852, the *Francis Skiddy* " " " " 7 " 24 "
" 1862, the *Daniel Drew* " " " " 6 " 51 "
" 1864, the *Chauncey Vibbard* " " " " 6 " 42 "

and there has been no reduction of time since that date.

Especially interesting is Spafford's description of the catamaran type of ferryboat, with wheels centrally placed, in view of the fact that not many years ago the technical papers described a ferryboat of this type as an interesting departure from the common method of ferry construction. This led to a searching of records of early steamboat navigation, which revealed the fact, that Franklin himself suggested, about 1790, the use of a jet of water pumped out of the stern of a boat. Franklin afterward concluded that no great speed would be attained, and, after Rumsey had experimented, gave up the idea.

It was left for some one, 100 years after Franklin, to actually build a pump and a boat after Franklin's idea, and, after much heralding in the newspapers and expenditure of money, arrive at Franklin's conclusion that this method of propelling ships was not practicable. Even more interesting is the fact that, in 1804, Col. John Stevens built a twin-screw steamer, 68 feet long, 14 feet beam, which for some hitherto unpublished reason was not called a success. The fact is that this same machinery was placed in another hull, in 1844, and then made 8 miles an hour, while Fulton's boat, in 1807, made only 5 miles an hour. This machinery is now in the museum of Stevens Institute, Hoboken, N. J.

L. F. Bellinger.

Glasgow's Success Due to its Mercantile Fleet.

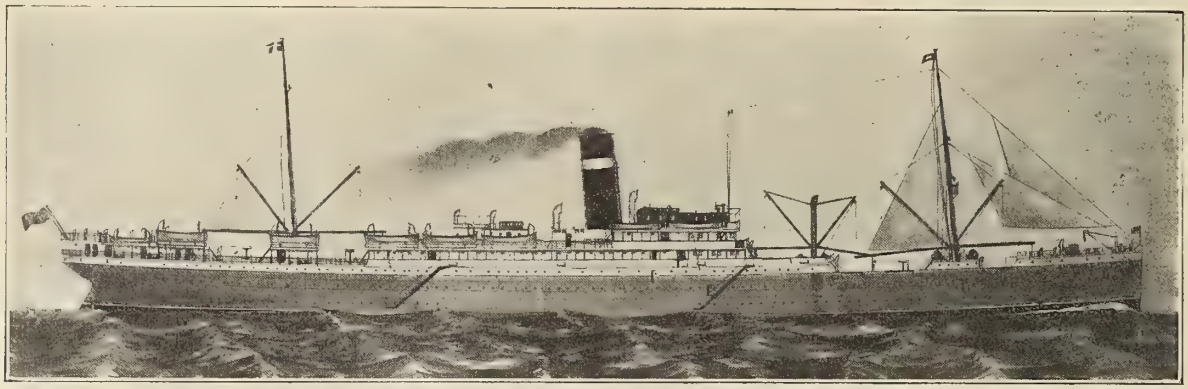
The wonderful trade enjoyed by Glasgow in distant lands owes its success to the thousands of steam and sailing vessels which enter every port in the world, laden with Scotch and English made goods. Glasgow's direct steamship lines give its exporters and manufacturers the cheapest and most direct transportation between the local factories and all foreign markets. This is an advantage which the United States manufacturers do not enjoy, and they will never be on an equal footing with their competitors until a merchant marine of their own is secured. The European manufacturer does not fear competition from his American rival so long as he has the advantage of thousands of passenger and cargo steamers on his side, and his commercial competitors are without the means of meeting him in the distant ports and markets of the world.

For the twelve months ending June 30, 1906, 1,913 vessels (1,849 steam and 64 sailing), of 3,326,328 tons, sailed out of Glasgow in the foreign trade, the following being the principal destinations, with tonnage: Africa, 350,941; British North America, 361,593; United States, 493,263; South America, 404,392; Australia and New Zealand, 148,301; China and Japan, 199,221; France, 208,845; India, 472,888; Italy, 202,822, and Spain, 157,015.

The nationality of the vessels entering the harbor during the year named and engaged in both foreign and coastwise trade, was as follows:

	Sailing	Steam	Tonnage	Average
Great Britain	482	15,199	5,274 967	337
Austria	—	15	21,604	1 440
Belgium	—	11	26,893	2 445
Bulgaria	—	1	1,164	1,164
Denmark	3	3	3,640	607
France	16	10	38,534	1,482
Germany	1	16	10,143	597
Italy	—	16	25,525	1,595
Norway	6	141	94,384	636
Spain	—	33	31,273	948
Sweden	1	47	32,600	679
Total	509	15 492	5 569 727	348

Not a vessel entered the harbor during the year 1906 flying the flag of the United States. The records for six years past disclose the astonishing fact that while 1,130 loaded ships



THE NEW ALLAN LINE STEAMER CORSICAN, AS SHE WILL APPEAR WHEN COMPLETED.

sailed from Glasgow to the United States, every one of them carried a European flag. The local market value of the goods carried on these vessels to the United States in the six years amounted to $37,016,949 (£7,606,480). This does not include an average annual passenger list of 25,000 persons. As the value of the importations from the United States into Glasgow exceeds the exports, the vessels leaving this port returned with cargoes the estimated cost of which in America was no less than $50,000,000 (£10,275,000). Glasgow has 110 separate firms and corporations owning steam and sailing ships engaged in the foreign and coastwise trade. In some instances a single company owns as many as thirty vessels, the tonnage of many of these being over 8,000 tons. The number of local shipping offices and agents engaged in extending the foreign commerce is 569.

The Clyde Navigation Trust collects all harbor dues from ships entering and leaving the port. The annual revenue in 1863 was £121,322 ($590,415), while the revenue for 1906 was £543,068 ($2,642,845). The quantity of goods in and out of Glasgow in 1863 was 1,437,235 tons; in 1906 the record was 9,256,218 tons. This tonnage is foreign and coastwise trade.

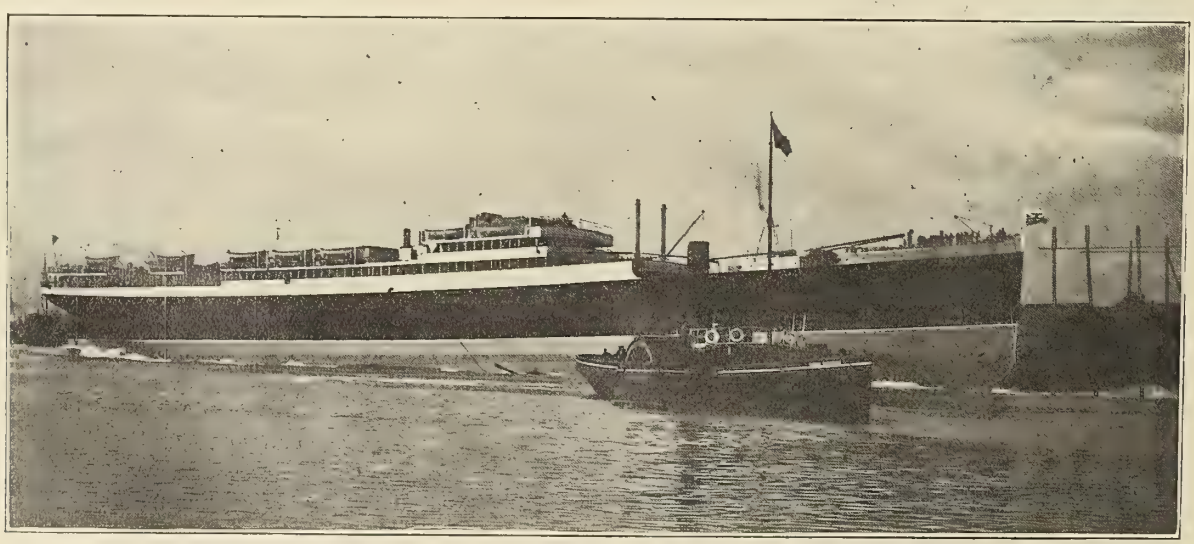
The practical benefits of a merchant marine, and how it has aided in the development of a new industry in Glasgow during the past fifteen years, until it has outstripped its older rivals in the United States, is shown in the case of a well-known sewing-machine company. Its capital is English and its active management is in the hands of able and experienced Americans. This plant was built in the suburbs of Glasgow fifteen years ago. To-day it gives employment to 11,000 people, and during the past year it manufactured 1,000,000 sewing machines. These machines were sold in Central and South America, on the continent of Europe, and all over the Far East. They reached these desirable markets through the medium of Glasgow's merchant vessels. This was an advantage its rivals in the United States did not enjoy, and hence during these years have missed the sale of millions of machines. With equal shipping facilities—direct lines and cheap transportation—and having all the raw material in America, the Glasgow plant could not undersell the sewing-machine companies of the United States in the foreign markets of the world.

A merchant marine is not only imperatively needed now, but without it the Panama Canal will be of far greater service to foreign manufacturers, exporters, and the great shipping world of the old country than it will be to the great Republic which will build and own it.—*Consular Report.*

The Allan Line Steamship Corsican.

In the twin screw ship Corsican, which was launched on April 29 last, and which is intended for the Liverpool-Canadian traffic, Messrs. Barclay, Curle & Company, Limited, Whiteinch, have embodied all the accumulated results of a long and varied experience in the building of ships. The leading particulars of the vessel are:

Length	516 feet
Breadth	61 feet 3 inches
Depth from bottom of keel to top of deck at center	42 feet 9 inches
Gross registered tonnage about	12,000



LAUNCHING OF THE ALLAN LINE STEAMSHIP CORSICAN, BY BARCLAY, CURLE & COMPANY.

Triple expansion twin-screw engines of 8,500 indicated horsepower, constructed by the builders, will give a speed at sea of 16 knots. Provision is made for 300 first class passengers; 400 second class, and 1,500 third class.

No effort has been spared to obtain construction of the first quality, the vessel not only conforming to the highest class in the British Corporation, but possessing considerable additional strengthening in order to suit the owners' special needs. The hull generally has been constructed of mild steel, Siemens-Martin open hearth process. It is divided into separate watertight compartments by seven bulkheads, and to further insure immunity from danger in the event of collision or stranding, a complete inner bottom is fitted, divided by numerous partitions into separate water ballast tanks, each tank being capable of being filled or emptied independently, so that the trim and draft of the vessel can be adjusted at any time to suit the conditions of service.

Four complete steel decks are fitted, the orlop, lower, main and shelter; the last named being completely sheathed with pitch pine, while the lower and main are covered with terrano, a substitute for wood. Above the shelter deck at the fore end is the forecastle deck, providing accommodation for stewards, fireman and crew. At the after end is a long combined poop and bridge sheathed with pitch pine, forming a promenade which is assigned partly to second class passengers and partly to third class. Above this is the promenade deck, which is reserved exclusively for first class passengers, and above this again is the upper bridge deck, on which is placed the officers' quarters. The flying bridge, which is used for navigating purposes, is formed by an extension of the roof of the officers' house.

The now general practice of placing a number of staterooms on the promenade deck has been adhered to in this vessel, these rooms accommodating two occupants, which fact, coupled with the obvious advantages of situation, should make them the most popular on board. The passages throughout the accommodation are extra wide, having abundance of light and air. The ventilation has received special attention, the usual method of tube ventilator being supplemented by a complete installation on the thermo-tank system.

The first class dining saloon is situated in the deckhouse at fore end of bridge deck, extending right across, and is lighted by extra large square windows on three sides. The decoration is carried out simply and in good taste, the paneling being in oak, with white enameled ceiling relieved with gold. Adjacent to this is the pantry. A cold chamber is provided on orlop deck where perishable provisions may be kept at any desired temperature.

The music room is situated on the promenade deck, with large square windows around three sides. The decoration is carried out in white, with mural panels of silk, the ceiling enameled white and picked out in gold.

The first class smoke room, placed at the same level as the music room, is well lighted and ventilated, and as a further aid to ventilation a large teak skylight is fitted above the center of the room. The decoration is in fumed oak with ceiling in white, and comfortably placed seats and tables are fitted, together with a bar leading directly off this room.

The electric light installation consists of two independent dynamos, each driven by compound coupled engines, a complete system of electric lighting being fitted throughout the ship, including navigating lights and large clusters for use when discharging cargo at night. A Marconi installation is fitted on board. The safety of the passengers has been considered by the provision made by sixteen lifeboats and ten collapsible boats having patent lowering and disengaging gear.

The vessel has a capacity for carrying 11,000 tons of deadweight. Cargo loading and discharging facilities are unusually complete, six large cargo hatches being served by twelve powerful winches and derricks to suit, and a powerful warping winch in the steering gear house. Large tanks capable of containing about 400 tons of fresh water are built into the ship for the service of passengers.

The machinery, which has been constructed by the builders, consists of two sets of triple expansion engines, the diameters of the cylinders being 28, 47 and 79 inches, with a stroke of 54 inches. The intermediate and low pressure cylinders are fitted with flat slide valves. Direct steam starting and reversing gear is fitted, also steam and hand gear for turning engines in port. The surface condenser is horizontal and built of steel plates with cast iron ends, the condensing surface being 6,000 square feet. The propellers are three-bladed, having cast iron bosses and blades of manganese bronze.

The boilers are seven in number, with a working pressure of 190 pounds per square inch. Each boiler is fitted with four furnaces. Howden's forced draft is supplied by two fans. The total number of furnaces is 28; the heating surface 22,000 square feet, and the grate surface 539 square feet, the ratio being 40.8 to 1.

Lloyd's Shipbuilding Returns.

The report showing the vessels under construction in the United Kingdom at the end of June gives a total of 501 steamers and 63 sailing vessels, amounting in the aggregate to 1,250,318 gross tons of merchant steamers, as compared with 1,409,456 tons one year previous. All but 21 of the ships are built of steel, one steamer being of iron, and 20 sailing vessels of wood or composite construction. The ownership of these vessels is very largely British, the gross tonnage for the United Kingdom being 803,991, while the colonies account for 54,118 tons. The remainder of the tonnage is distributed among twenty or more nationalities, the largest buyer being Austria-Hungary, with 54,690 tons. Holland, Italy and South America are accredited with about 46,000 tons each, while France and Germany are between 35,000 and 40,000 tons. The United States is buying two vessels, of 2,500 tons.

Of the vessels under construction, three steamers are of upwards of 20,000 tons; two others are of more than 15,000 tons, and seven others more than 10,000 tons. None of the sailing vessels exceeds 1,000 tons, except one which is classed as an "oil barge," and is over 6,000 tons.

Merchant shipbuilding in other countries is also tabulated, the vessels under construction in Germany being given as 93 in number, of 278,762 tons. The United States, excluding the Great Lakes, accounts for 74 vessels of 117,256 tons. France is a close third, with 31 vessels of 106,396 tons. Holland, Japan and Italy follow with 68,852 tons; 65,698 tons; and 64,120 tons, respectively.

Warships under construction in the United Kingdom include 2 battleships, 3 armored cruisers, and 2 submarines in the royal dockyards; 6 battleships, 20 destroyers, and 8 submarines in private yards, for the British government; and 2 battleships, 1 armored cruiser and 10 destroyers in private yards for outside owners. The aggregate of the 41 British vessels is 198,072 tons displacement, or an average of 4,831; while the 13 foreign vessels account for 57,120 tons, or an average of 4,394. The total for the 54 vessels is 255,192 tons. It may be noted that none of the vessels listed, with the exception of the experimental destroyer *Swift* of 1,800 tons, has a displacement between 1,000 and 14,000 tons. In other words, the ships are very sharply divided into two types, one being battleships and armored cruisers, all of over 14,000 tons; and the other being torpedo vessels, all but one of which are under 1,000 tons displacement each. The intermediate types, in the shape of protected cruisers, scouts and small armored cruisers, have entirely disappeared, so far as vessels under construction in Great Britain are concerned.

Experiments on the Wind Resistance of Ships.*

BY F. H. ALEXANDER.

Our knowledge of the reduction of a vessel's speed owing to the resistance caused by wind pressures upon her exposed structure is in a very rudimentary state. My object in bringing this paper before the Institution is to suggest a comparatively inexpensive method whereby some experiments might be carried out to increase that knowledge.

The apparatus needed consists of three parts: (1) a floating framework, (2) the ship structure to be tested, (3) the recording gear. Figure 1 shows the arrangements of the floating framework, intended to be moored in an open sheet of water, free from currents. This framework consists of a principal member, *A;* transverse members, *BB* and *CC,* diagonally stayed to *A,* at its forward end; three watertight trimming boxes, *D;* breakwater logs at front and sides, *E;* and breakwater sparring from *BB* to *CC.* The object of the breakwaters is to give smooth water about the tested structure. Figure 2 shows a plan of the watertight portion of this ship structure. It consists of two pontoons, *F,* separated so as to clear the trimming box on *A* (Fig. 1), and free to move aft under wind pressure against the tension of the dynamometer spring, *G,* which is attached to *D,* and extended by the connections, *H,* secured to the ship. These side pontoons are decked over and otherwise connected, and form the 'midship, permanent, and buoyant part of the ship. Portable non-watertight ends, erections, and other parts of any suitable construction can be added or removed as desired.

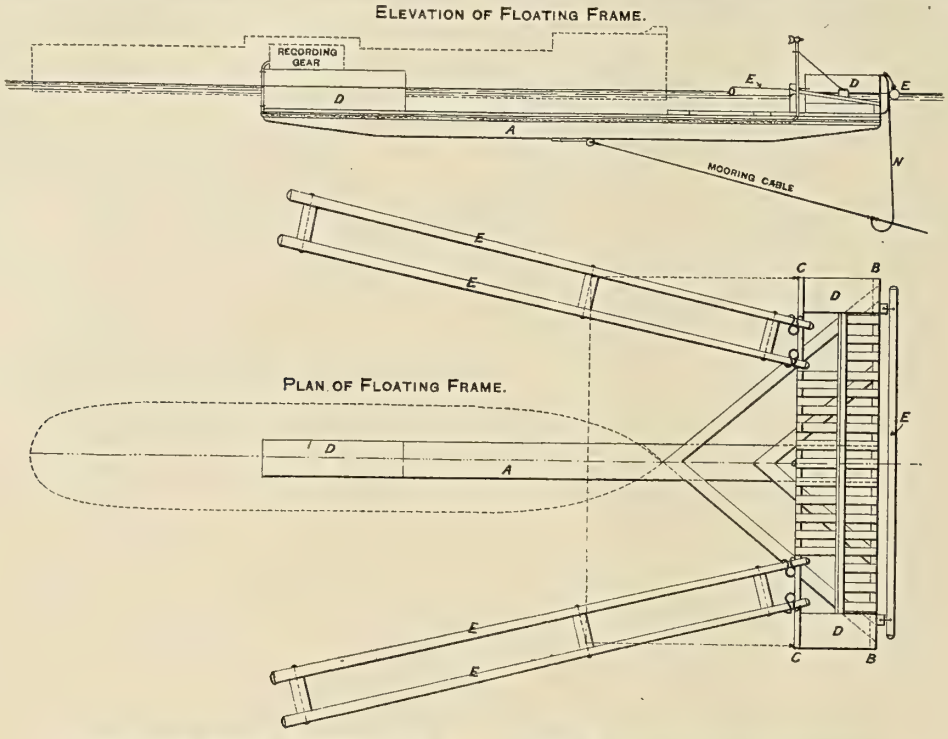


FIG. 1.—THE GENERAL ARRANGEMENT OF THE APPARATUS FOR MEASURING WIND RESISTANCE.

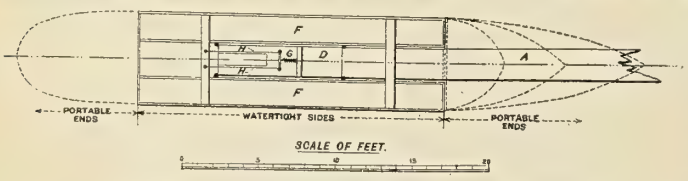


FIG. 2.—PLAN SHOWING WATERTIGHT PART OF VESSEL.

Figure 3 shows, on an enlarged scale, an elevation, plan and cross section of the dynamometer and recording gear; and of the sliding hatches covering these parts. The recording apparatus consists of a Lander's wind-speed recorder, *K;* and a resistance or pressure recorder, *L,* which indicates the extension of the spring, *G.* The records are traced upon a sheet of paper secured on the time-revolving drum *M.* Upon the diagrams so obtained, fixed tracers indicate the lines of zero wind pressure and speed, and, if desired, a time record can also be traced in the usual manner. Provision is made (1) to support the tracing links if, in extreme cases, they are moved beyond the limits of the drum, (2) to remove the tracers and links, and the drum, when it is desired to adjust them.

It is probable that it would be preferable to elongate the member *A,* so that it should project behind the vessel, and to erect upon its after end the necessary recording gear quite clear of the vessel herself, so that there might be no interference with the erections amidships in getting at the records; this, however, would involve extra cost in the framework.

The necessary adjustments of drum, tracers, and clockwork having been made, the apparatus is left to itself to record the variations of wind-speed and pressure. The floating frame and the ship swing head to wind, no matter what the direction of the wind may be. When the paper is removed from the drum the diagrams traced upon it may be analyzed at leisure. On Figure 3 is shown an imaginary specimen of the lines obtained, and it is proposed to determine the mean pressure-effect corresponding to a mean wind-speed, by taking any portions of the figures, such as those shaded, integrating (by planimeter or otherwise) and determining the mean heights in the usual manner; the scales for speed and pressure being known by calibration.

Strictly speaking, a correction should be made to the readings given by the speed recording tracer. This correction varies with the ratio of the arc to the chord of the angle turned through by *K.* It would amount to only half of one percent at the extreme extension, and it has not been thought advisable to attempt to correct it by introducing mechanism which might in itself cause greater error. The correction can be mathematically determined, if such accuracy is considered advisable. The correction is not involved in the usual method of applying Lander's instrument, because the tracer in that case describes arcs of circles and not straight lines, as in the application here proposed.

It is not lost sight of that, unless prevented, the drum would revolve even when no wind was blowing, or was too light to give records of any practical value; hence a pawl attachment is made

*Read before the North-East Coast Institution of Engineers and Shipbuilders, February 15, 1907.

to stop the clockwork unless the pressure exceeds a certain value.

It is hoped that the use of this method would enable us to obtain information about the following and other points:

(1) The law of variation of pressure with wind-speed upon such structures.

(2) The variations of pressure at a given wind-speed:

(*a*) Upon full bow forms as compared with fine ones.

(*b*) Upon flat ended as compared with round ended erections.

(*c*) Upon "stepped-back" tiers of erections as compared with those whose fronts are in a vertical plane.

(*d*) Upon various arrangements of deck houses, funnels, masts, rigging, and other wind-catching details.

As it is possible that the resistances in some cases would be increased when the vessel is not directly head-on to the wind, but at an angle to it, the bridle *N* (Fig. 1), can be used to slew the floating framework and the vessel to the desired angle. The recording apparatus will then indicate the fore-and-aft component of the pressure, and the true wind speed. The total pressure will be found by multiplying the fore-and-aft component by the secant of the angle through which the apparatus has been slewed.

The value of obtaining a knowledge of the wind resistance of ships lies in the possibility that there may be cases where, without prohibitive cost, modifications in the above water design may greatly reduce the resistance, especially in strong head winds. It may be remarked that this is of special importance in vessels of relatively low power, whose speeds when in ballast condition are sometimes reduced by gales almost to zero.

Laboratory experiments with planes exposed in steady air currents must, of course, be made in order to determine the laws of the distribution of pressure over such simple surfaces, but it is reasonable to argue that a test such as is herein proposed is more in accordance with the conditions a ship has to meet. Nature's winds are not usually steady air currents, and the many-surfaced exposed parts of a ship are not simple planes.

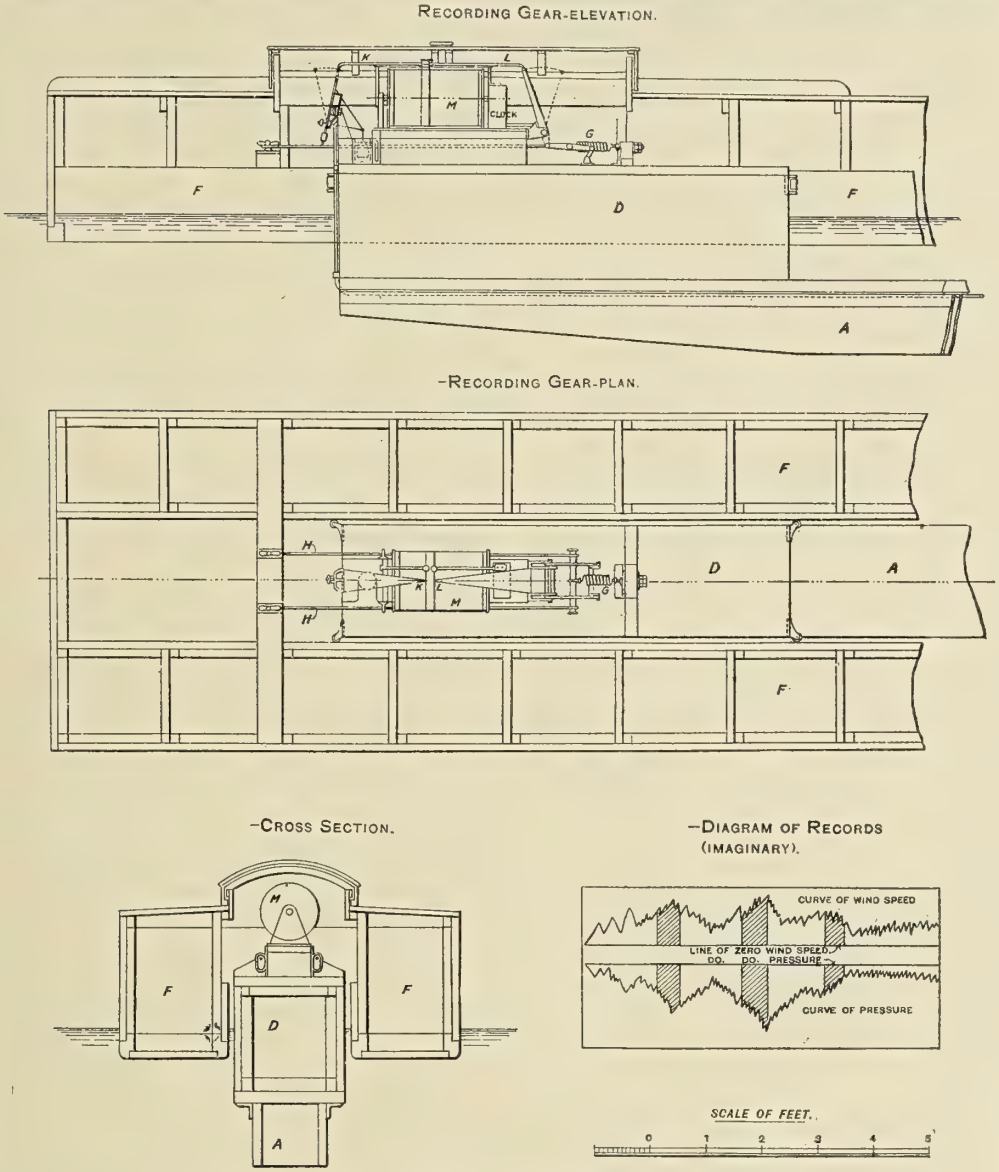


FIG. 3.—DETAILS OF THE RECORDING APPARATUS FOR WIND RESISTANCE MEASUREMENT.

It will be observed that, with the view of reducing cost, the watertight parts of the apparatus have been kept as small as possible. The vessel shown in the figures is about thirty to fifty feet long. It has been estimated that the first cost of such an apparatus would be from £100 to £120 ($500 to $600). It is probable that a larger structure would give more valuable results. The cost of carrying out a complete series of experiments would, of course, depend upon the number and construction of the structures tested, and upon the time given to the taking and analysis of the records.

An obvious defect lies in the necessity of awaiting nature's provision of the necessary strength of winds; and the alternative erection structures should be prepared beforehand, ready for immediate fitting as soon as a record has been obtained for a given form.

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The Speed Supremacy of the Atlantic.

From that day in the summer of 1889 when the *City of Paris* of the Inman Line completed the first trip across the Atlantic ocean on record in under six days, the rivalry for premier speed honors among the great steamship companies has been intense. In 1890 and for two years thereafter the supremacy of the *City of Paris* was hotly contested by the *Majestic* and *Teutonic* of the White Star Line. First, one of the trio, by a mighty burst of speed, would forge ahead of her rival, and in a short time another would displace her. With the advent in 1893, of the Cunard liner *Campania,* followed shortly by the sister-ship *Lucania,* both of much higher speed than any of their predecessors, the issue was left between these two last mentioned ships.

So far, the British flag had floated over all these competitors, for the *City of Paris* did not assume her American registry until 1893, when she became the *Paris,* and later, the *Philadelphia,* of the American Line.

In 1897 new blood was infused into the struggle with the appearance of the North German Lloyd steamer *Kaiser Wilhelm der Grosse* which with an advantage over the Cunarders of about three-fourths of a knot wrested absolutely from them the pre-eminence in speed which they had hitherto enjoyed. This ship was followed by the *Kronprinz Wilhelm,* the *Kaiser Wilhelm der Zweite* and the *Kronprinzessin Cecilie* of the same line, the last mentioned being new this year, and by the *Deutschland,* of the Hamburg-American Line. All four of these last mentioned ships have speeds of over twenty-three knots and both the *Deutschland* and the *Kaiser Wilhelm der Zweite* have held records.

All these records, however, will very probably soon be lowered by the new Cunarder *Lusitania.* This ship, which we describe at some length in another column, and which has been partially described a number of times in our pages, has taken up the cudgels to such effect that the blue ribbon of the Atlantic ferry is almost certain to pass again under the control of the British flag. Her marvelous record on trial trip has been well borne out by her maiden trip across the Atlantic, and there can be no doubt that when the machinery gets a little more used to its work, and the ship "finds" itself, still better results will be achieved. At present we can but congratulate the owners and builders of this magnificent vessel for the nerve and energy which they have displayed in her inception and construction, and for the daring which characterizes the entire design.

Shipbuilding in the United States.

The Bureau of the Census has just published a report on shipbuilding in the United States, which is a part of the census of manufactures of 1905, covering the calendar year 1904. According to these statistics 1,097 establishments, exclusive of those conducted by the Government, were engaged in iron and steel or wooden shipbuilding. The combined capital of these establishments was $121,623,700 (£24,992,000). They employed, on an average, 50,754 wage-earners, paid $29,241,087 (£6,008,400 in wages, used materials costing $37,463,179 (£7,698,000) and manufactured products which, including repair work, were valued at $82,769,239 (£17,008,000).

As the construction of iron and steel ships has grown in importance since 1880, capital has become more essential to the development of the industry. During this time the altered conditions, the rapid transition from wood to iron and steel construction, have produced a progressive concentration of shipbuilding in large establishments. In 1880 the 2,188 establishments involved an investment of $20,979,874 (£4,310,900) and, including repair work, gave an out put of $36,800,327 (£7,561,900). Twenty-five years later nearly six times the amount of capital invested in about one-half the number of establishments, 1,097, gave an output valued at $82,769,239 (£17,008,000).

In 1905 no less than 83.5 percent of the entire shipbuilding capital of the country was invested in iron and steel construction, as against 77.4 percent for 1900. Of the total number of private establishments reported in 1905, on the other hand, 95.1 percent were engaged in wooden construction work, for of the entire number of shipbuilding establishments not under governmental control only 54 were devoted to iron and steel construction, while 1,043 were credited to wooden construction. For

1900 the relative position of the two branches was nearly the same, as the number of establishments was 44 for iron and steel and 1,063 for wood. The majority of the establishments engaged in iron and steel construction are of great size and require costly and expensive equipment, while most of those engaged in wooden construction are small yards.

Within the last fifteen years the increasing importance of iron and steel in shipbuilding has been especially marked. As an item of expense in 1890 the cost of iron and steel was less important than the cost of lumber, but in 1905 the cost of the former constituted 41.2 percent and the cost of the latter only 17.9 percent of the amount paid for materials. In 1880 the value of the work done on wooden vessels of five tons and over was nearly three times as great as the value of work done on iron and steel vessels of the same class. For 1905 conditions were practically reversed, for the value of iron and steel work was nearly four times that of wood. The value of iron and steel construction was $43,395,704 (£8,917,100); and of wooden construction $9,724,231 (£1,998,100); the total, $82,769,239 (£17,008,000), being completed by an output from small boats under five tons, from repair work, and from all other products.

Nearly three-fourths of the value of products of the shipbuilding industry was produced in the Atlantic and Gulf district. Although there was a greater number of establishments on the Great Lakes than on the Pacific coast, the value of the output of the latter was greater from the fact that on the Great Lakes many small establishments exist because of the market there for small boats.

An increasing navy has compelled the Government to equip the navy yards adequately for the repair work which necessarily results from the large number of vessels now continually in commission. Government yards have also undertaken the construction of the largest types of war ships. As a result, the value of products of the Government establishments increased from $11,022,312 (£2,264,800) for 1900 to $17,265,469 (£3,547,800) for 1905, or 56.6 percent.

Although the number of vessels of five tons and over launched during 1904 was less by 167 than the number launched in 1880, the tonnage had increased 40.5 percent during the period, and the average tonnage of the vessels launched, 50.9 percent. The average value of the 2,415 vessels launched in 1880 was $7,961 (£1,637), whereas in 1905 the average value of the 2,248 vessels was $32,683 (£6,716). Of the total net tonnage launched for the merchant marine during 1904, 67.9 percent was destined for the lake and river traffic. There is little building for foreign trade. Of the total net tonnage launched for the merchant service, only 5.2 percent were destined for foreign trade. The fact that vessels for the coastwise, lake, and river service are required by law to be American built has made it possible for shipbuilding to maintain a firm footing in the United States.

The Speed of Battleships.

Some interesting facts have been brought out by the late Mr. Normand in a discussion, which is rather more suggestive than complete, on the size of battleships as a function of their speed (see page 417). Mr. Normand has attempted to determine the law by which the size of a battleship of certain length, beam and draft, varies with the speed when the other properties such as armor, armament and radius of action remain fixed. Taking the typical case of a modern battleship of certain dimensions, he finds what increase of displacement will result from a reduction of power sufficient to decrease the speed one knot. Of course the first thing that suggests itself is that a decrease of power means a direct reduction in the weight of the propelling machinery. This does not vary directly as the power, but in the typical case was found to be about 1.5 percent of the original displacement. It is interesting to note in this connection the figures given by Commander Hovgaard in his paper on the speed of battleships read before the Bordeaux Congress of Naval Architecture, showing the possible increase of power that can be obtained on a given weight of machinery and fuel by taking advantage of such recent technical improvements in propelling machinery as the use of oil fuel, small tube boilers, and turbine machinery. He estimates that it might be expected to increase the power on a given weight of machinery about 34 percent. Likewise a saving in weight of the machinery might be expected for a given power although not in the same proportion.

Besides the direct reduction in the weight of the propelling machinery available when the speed of the ship is reduced one knot, an increase of displacement can be obtained by diminishing the fineness of the lines in the slower ship. This added displacement in the case of the typical ship amounted to about 2.7 percent of the original displacement. Another slight increase in displacement may be obtained in the reduction of the upper works of the ship when designed for the slower speed. This saving amounts to about .5 percent of the original displacement. Thus the total saving in weight in the case of the typical ship, due to a reduction of speed of one knot, Mr. Normand found to be about 4.7 percent of the original displacement, which, of course, could be used to increase the percentages of weight allowed for armor, armament or fuel, or the ship could be reduced in size by just that amount.

The results obtained by Mr. Normand's approximate formula have been shown by subsequent model basin experiments to represent a very conservative estimate of the increase in displacement, which can be obtained by a reduction of speed. These model basin experiments further show the effect of fineness in the ship at high speed. In vessels of the same dimensions but of different displacements, at high speed the percentage increase in power necessary to gain equal increments in speed increases very rapidly in the case of the larger ship, although at moderate speeds the increase of power is about equal to the percentage increase of displacement.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reports under date of August 10, 1907, the following percentage of completion of vessels building for the United States Navy:

	Tons	Knots		July 1	Aug. 1
BATTLESHIPS.					
Mississippi	13,000	17	Wm. Cramp & Sons	88.96	90 32
Idaho	13,000	17	Wm. Cramp & Sons	81.98	83.98
New Hampshire	16.000	18	New York Shipbuilding Co.	75.4	80.
South Carolina	16,000	18½	Wm. Cramp & Sons	17.48	19.59
Michigan	16,000	18½	New York Shipbuilding Co.	19.4	21.2
ARMORED CRUISERS.					
South Dakota	13,680	22	Union Iron Works	97.5	98.
North Carolina	14 500	22	Newport News Co.	83.77	86.34
Montana	14,500	22	Newport News Co.	76.96	80.
SCOUT CRUISERS.					
Chester	3,750	24	Bath Iron Works	81.26	85.
Birmingham	3,750	24	Fore River Shipbuilding Co.	81.6	82.9
Salem	3,750	24	Fore River Shipbuilding Co.	80.8	82.67
SUBMARINE TORPEDO BOATS.					
Cuttlefish	—	—	Fore River Shipbuilding Co.	97.	99.
Viper	—	—	Fore River Shipbuilding Co.	95.	97.
Tarantula	—	—	Fore River Shipbuilding Co.	97.	99.
Octopus	—	—	Fore River Shipbuilding Co.	95.	97.

ENGINEERING SPECIALTIES.

The Moorings For the Largest Ships in the World.

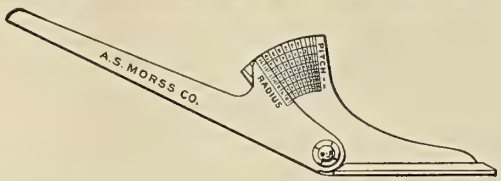
It is not easy to give an adequate idea of the size of the huge mooring chains for the Cunarders *Mauretania* and *Lusitania*, which quite throw in the shade the 3¾-inch cables used on the

vessels, but some idea of the size may be gained from the following particulars. The total weight of the moorings is over 200 tons and the anchors weigh 12 tons each. Each common link of the chain shown weighs 243 pounds, and each end link 336 pounds, the diameter of the iron being 4¼ and 5⅜ inches, respectively. The swivel connection in the center weighs 4,485 pounds, and each shackle 711 pounds.

The photograph shows the main connection where the buoy pendant joins the bridle chains, of which there are four, each 720 feet long, and the main chains are composed of square links each nearly four feet long, and weighing about 4 hundredweight apiece. These moorings were manufactured by Messrs. Brown, Lenox & Co., of Pontypridd, for the Cunard Steamship Co., and the chain was entirely manufactured at their works in South Wales, from the forging of the bars to the casting of the studs. They also supply the 12-ton anchors for the mooring.

A New Pitchometer.

A small instrument used for determining the pitch of a propeller is being placed on the market by the A. S. Morss Company, 120 Commercial street, Boston, Mass. It is so adjusted by means of a table etched upon the surface that the pitch of a blade at any given point may, with a little care, be read at a glance. This not

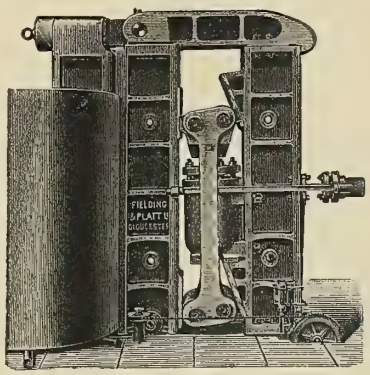


only permits the determination of the pitch of the propeller, but also affords opportunity for comparing one blade with another, and for noting differences of pitch between the tip and the hub of the blade. The instrument is made of tool steel, nickel plated, and is particularly suitable for work in connection with motor boats.

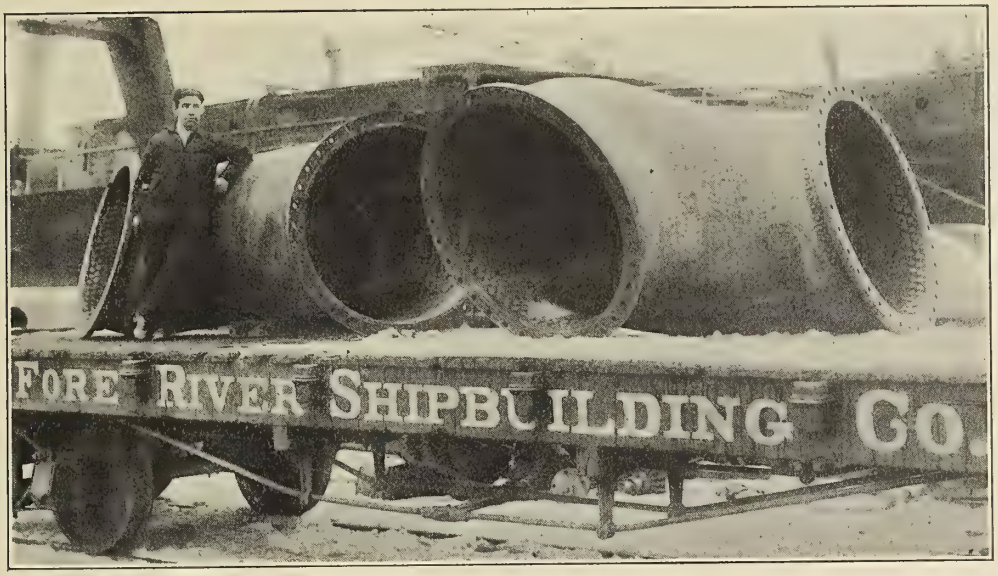
In measuring the pitch, the propeller is laid on a table or other flat surface, with its axis perpendicular. The pitchometer is then placed against the edge of the blade perpendicular to its axis, and about two-thirds the length of the blade from the center of the shaft. This distance must be an even number of inches, as the radii for which the table is calculated are in even inches. Adjust the arm of the instrument to lie flat on the blade, and read the pitch in the proper column.

A New Hydraulic Boiler Plate Bending Machine.

A machine of a new type for bending the shell plates of a boiler is being placed on the market by Fielding and Platt, Ltd., Gloucester. This machine is intended to overcome some of the of the disadvantages which are found in rolling plate with ordi-



nary bending rolls. With it it is possible to bend the plate to a true curve clear to the edge of the plate so that it is unnecessary to shape the edges with hand hammers. In a similar manner narrow strips of plate such as butt straps, liners, etc., can be easily and accurately bent to a true curve. It is a vertical machine and therefore occupies very little floor space, the machine capable of bending plates 1⅝ inches thick and 13 feet wide, taking up a space of only 15 feet long by 5 feet 6 inches wide. It is operated with hydraulic power and is fitted with a patent automatic gear feed for feeding plates through the machine.



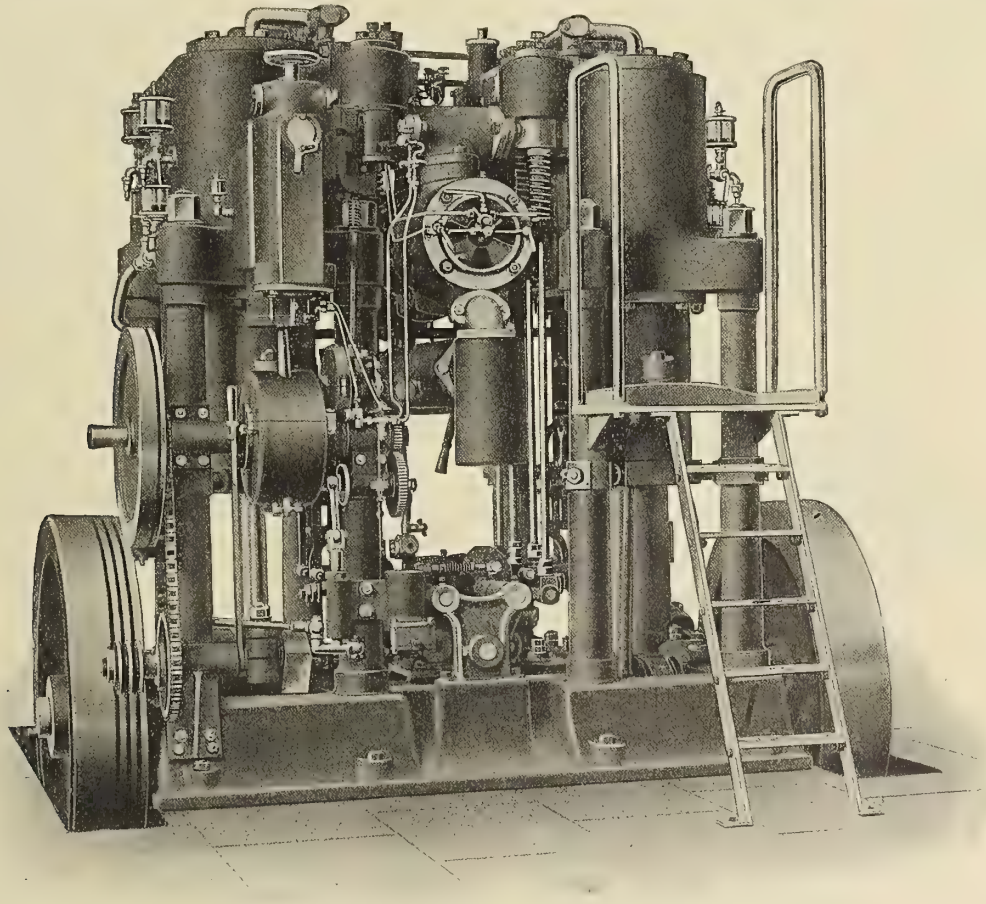
Large Copper Elbows.

As examples of heavy copper pipe work, the offset elbows shown are particularly interesting, being of unusual weight and size. They are in the main exhaust lines of the Curtis' turbine steamship *Creole,* and were made at the copper shop of the Fore River Shipbuilding Company, Quincy, Mass., the builder of the vessel. Each of these elbows weighs 2,500 pounds, is 42 inches in diameter inside and 5/6 inch thick. Four pieces of sheet copper were used in the making of each elbow, and the skillfulness with which they were brazed together is apparent in their smoothness and shapeliness. As specimens of excellent workmanship they will appeal to coppersmiths, for these elbows are nearly, if not quite, the largest copper ones ever made in the United States for marine purposes.

The Griffin Marine Oil Engine.

The motor built by the Griffin Engineering Company, Limited, Kingston Iron Works, Bath, is vertical, having two cylinders in the smaller sizes and four in the larger, fitted with very long pistons (about 1½ times the length of the stroke). These pistons are connected at their outer ends by a rigid crucible steel crosshead, which, by means of a single connecting rod, actuates a single crank, an impulse at every revolution being thus obtained in the simplest possible manner, with the minimum of mechanism.

Any kind of ordinary refined paraffin (kerosene) or crude unrefined mineral oil can be used, with flash points varying from 75 to 250 degrees F., no special adjustment of any kind being necessary. The motor after being started is said to be absolutely



self-regulating, neither oil feed, air supply, or ignition requiring the slightest attention; all conditions of load, from light running up to full power, being automatically controlled by the governor; half or any intermediate speed being obtained by a small suitably arranged hand lever or pedal.

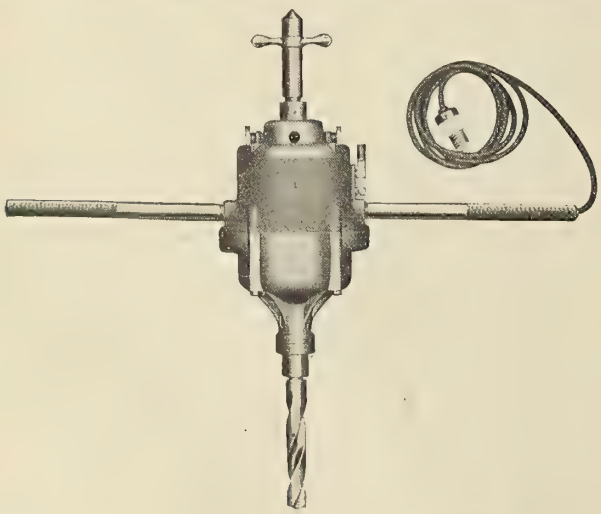
The method of forming the working charge is entirely new, giving an economy and cleanliness in running said to be unapproached in any oil engine of this type. The oil, which is sprayed in a finely divided state into a vaporizer, afterwards passes (in a vaporized state, and mixed with a suitable quantity of air) into the cylinders, where it is compressed and ignited, giving power to the pistons. The vaporizer, which is heated by the exhaust gases only, never exceeds a temperature of 400 degrees F.; thus the oil cannot, under any possible conditions, be decomposed or gasified, and consequently no tarry deposit (so fruitful a source of trouble in other engines) is ever formed. The cylinders, pistons, and all internal parts thus remain perfectly clean, even after many months of constant working, while at the same time, the whole of the heating constituents of the oil being completely burnt in the cylinder, the greatest possible economy is secured.

The engine is built for marine purposes in sizes of from 6 to 500 horsepower. The consumption of ordinary petroleum is about 300 grammes (⅔ pound) per B. H. P. per hour. Ten to twelve minutes only are necessary for starting the larger size motors from cold. These motors are said to be very simple, easy to run and very strong. A motor of 45 I. H. P., at 300 revolutions per minute, complete with reversing gear, weighs 3,600 kilogrammes (7,940 pounds, or 176 pounds per I. H. P.).

It is claimed that they require no internal cleaning whatever, for they never get foul. The only part that requires occasional cleaning is the vaporizer, but this is exceedingly easy, and is the work of two or three minutes. These engines work without attention or adjustment of any kind, either with heavy petroleum, benzoline or alcohol. They also work perfectly with crude oil or tar oil obtained from the gas works. In France this latter is much cheaper than petroleum. The reversing clutch is very strong and gives no trouble. The speed is easily reduced by simply throwing the clutch out of gear from time to time. The oiling of the different working parts is very easy, all the bearings being visible and easily accessible.

The Hisey Portable Electrical Screw-Feed Drill.

We here illustrate a new type of electrical drill, made by the Hisey-Wolf Machine Company, Cincinnati, Ohio, which they are just putting on the market. It is made in two sizes, ⅞-inch

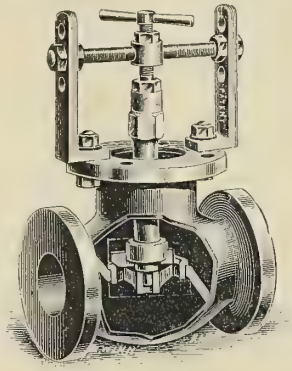


capacity (weight 27 pounds), and 1¼-inch capacity (weight 38 pounds). These capacities as given are for steel. Larger size holes can be drilled in softer material. The driving power is obtained from the ordinary incandescent lamp socket.

The motor is fully inclosed at the spindle end, preventing borings or chippings entering in any way. The switch is located on the body of the motor within immediate reach of the operator. The two side handles are detachable. An "Old Man" is furnished as an extra if desired. The gears and working parts are hardened. All parts are easily accessible for adjustment, and at the same time protected in every way. This drill is said to be simple, durable and compact, with no complicated parts to get out of order. It is especially built for the heavy work for which it is intended. The drills are particularly useful in machine shops, boiler plants, bridge building, construction work and shipyards. They can be carried anywhere, as any length cord can be attached.

Brooke's Patent Valve Re-seating Machine.

The illustration shows a new type of valve seat re-facer, designed specially for use by marine engineers. The machine is simple in all its parts but is capable of standing a fair amount of rough usage without getting out of order. Thus the tool should



prove valuable on cargo and tramp ships, where such tools are scarce. The machine is fastened to the flange of the valve by means of two legs, the feet of which can be turned inwards for small flanges and outwards for large flanges. When fastened in either way, no part of the machine obstructs the view of the operator. Once the machine is set in position the cutter can be changed by unscrewing the mandrel from the box nut. In this way any special cutter may be inserted. Long mandrels are provided for deep seated valves. Steadying devices are also provided for both plain bore and star ribbed seats, which not only center the end of the mandrel but obviate any tendency that it may have to vibrate. The machine is operated with an ordinary spanner. The manufacturers are Charles Winn & Co. Granville Street, Birmingham.

TECHNICAL PUBLICATION.

The Marine Steam Turbine. By J. W. Sothern. Size, 5½ by 8½ inches. Pages, 163. Figures, 77. New York, 1906. D. Van Nostrand Company. Price, $2.50, net.

This is the second edition of a work prepared by the author in response to a demand for practical information upon the latest developments along this particular line, and deals entirely with the Parsons type of turbine. It starts out in a very elementary way, with definitions of units used in steam engineering and mechanics generally, and explains the expansion of steam and its effect in the production of power.

The various details of design and construction are taken up in order, attention being given to such subjects as clearances, blading, packing, heat expansion, propeller dimensions, slip and cavitation, efficiencies of turbine and propellers, and steam and coal consumption. Figures are compiled from various sources, giving comparisons between turbines and reciprocating engines, particularly along the line of coal and steam consumption of similar ships at corresponding speeds.

The work seems to be thoroughly practical in all its details, is profusely illustrated with both half tones and line engravings, and gives a great deal of data from the actual operation of ships

propelled by turbines. The last chapter covers the torsion meter patented by Messrs. Denny & Johnson, and is followed by elementary problems in marine turbine design, with answers.

Personal.

Homer Parmelee died in Chicago, August 12, in his eighty-ninth year. He was a boiler maker who had added much to the science of the subject, and had made inventions along the line of pipe wrenches. His inventive genius was very marked.

QUERIES AND ANSWERS.

All reasonable questions concerning marine engineering received from and signed by subscribers will be answered by the Editor in this column. All communications must bear the name and address of the writer.

Q. 383.—Is it ever customary in multiple expansion engines to make the engine that the pumps are worked from larger than the others? P. G.

A.—The cylinder from which the pumps are worked in a multiple expansion engine is very frequently the low-pressure cylinder, and this cylinder is, of course, much larger than the others. This increase in size, however, is due wholly to the requirements for the expansion of steam and its economical use in the engine, and has nothing to do with the fact that the pumps are worked from the low-pressure crosshead. As a matter of fact, the power used in working these pumps is really furnished by the entire engine, because the relationship between the moving parts is such as to make for rigidity of operation in all directions.

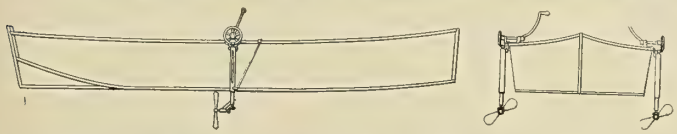
SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

857,868. MEANS FOR PROPELLING BOATS. WILLIAM G. BUSSE, BROOKLYN, N. Y.

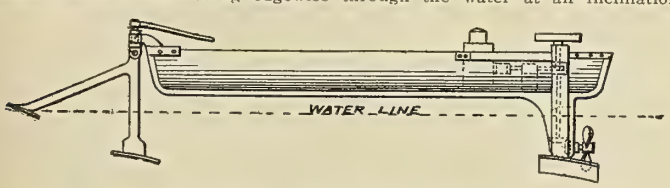
Claim 1.—Propelling means for boats, comprising an extensible shaft, means detachably supporting said shaft vertically from the gunwale of a boat, a propeller shaft disposed right-angularly at the lower end of said



vertical shaft, a propeller carried thereby, a bearing for said propeller shaft, an angularly disposed bracket supporting said bearing from the lower end of said vertical shaft, and means for turning said propeller shaft. Four claims.

857,951. WATER-CONVEYANCE. WILLIAM M. AND LARNED E. MEACHAM, CHICAGO, ILL.

Claim 1.—In a water conveyance, the combination with a body or vessel for receiving the passengers or load, of inclined supporting plates connected thereto and moving edgewise through the water at an inclination



to the longitudinal horizontal line, to give support to the body or vessel, and a regulating plate or float connected to the forward supporting plate for automatically regulating or adjusting the inclination of the supporting plate. Fourteen claims.

858,853. LAUNCHING APPARATUS. ALBERT T. BROCH, SAN FRANCISCO, CAL.

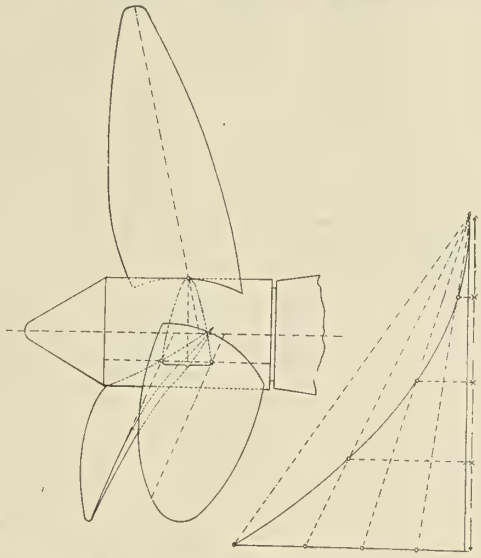
Claim 2.—In a boat launching apparatus, the combination of a launching cradle mounted for oscillation, means (including retaining members) engaging said cradle and operable in unison from the common center for holding said cradle in normally horizontal position, a shell having a keel beam supported in said cradle, and means engaging said keel beam to hold the shell against movement in said launching cradle. Seven claims.

858,854. LIFE-BOAT. ALBERT T. BROCH, SAN FRANCISCO, CAL.

Claim 1.—In a boat having an open portion, the combination of two cooperating covering devices, said devices movable toward and from each other to inclose the open portion of the boat, means for holding one of said covering devices nomally open and under tension, and means for releasing the normally held covering device to allow it to automatically close. Five claims.

858,749. SCREW-PROPELLER. FRIEDRICH AUGUST VON OLDENBURG, OLDENBURG, GERMANY.

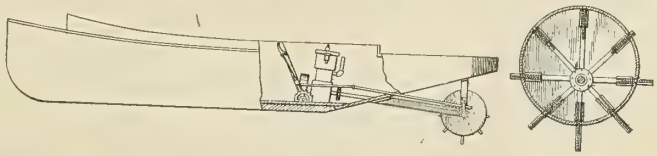
Claim 1.—A screw propeller having successive blades arranged one behind the other, from front to rear—with their centers located on one geo-



metric spiral line, and the base of each blade being arranged across and at an acute angle to the said spiral line, the angle of the bases of the several blades to said line being different. Five claims.

858,215. MARINE PROPELLER. OSCAR D. ROBINSON AND ROLLO L. BENNETT, OLIVET, MICH.

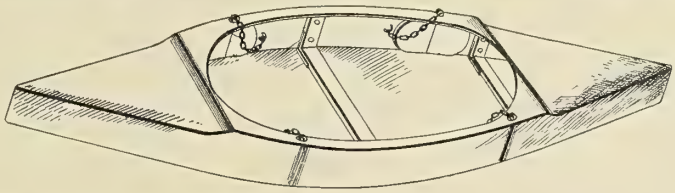
Claim 2.—A marine propeller embodying a rotary slotted drum, an eccentric shaft therein having cranked end portions on which the drum is journaled, blades sliding through the slots in the drum, a common hub to



which said blades are connected journaled on said shaft, a pinion on one of the cranked ends of said shaft, and a rack bar meshing with said pinion for turning the shaft to shift the eccentric portion thereon and change the throw of the blades relatively to the periphery of the drum. Two claims.

858,506. COLLAPSIBLE BOAT. FRED. H. FARRAND, LIDGERWOOD, N. D.

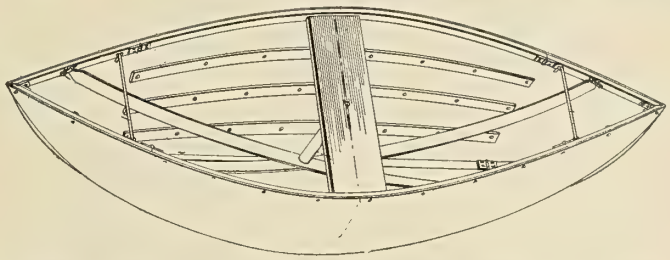
Claim 1.—A boat comprising a covering, sides composed of sections and detachable from the covering, means for holding the sides separated and



the covering under tension, and consisting of brackets applied to the opposite sides and having lateral extensions projecting from the sides near the lower edge portions thereof, and cross bars between the sides and having the ends thereof seated on the lateral extensions of the brackets. Three claims.

859,582. FOLDINGBOAT. ALBERT J. ROSIN, CLEVELAND, OHIO.

Claim 1.—In a folding boat, the combination with the keel and gunwales

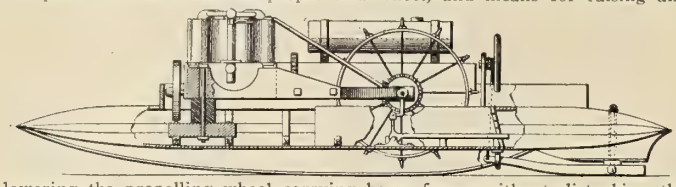


of the end sections hinged to the gunwales and to each other, and foldable inwardly between the gunwales, and the stems hinged to the keel and arranged to fold in and down upon the same. Four claims.

859,693. ICE AND WATER BOAT. NATHANIEL ROE, PATCHOGUE, N. Y.

Claim 1.—In a vehicle of the character described, a body mounted upon runners, a beam frame, nutted bolts at one end thereof securing it to the body, a toothed propelling wheel mounted at the other end of said beam

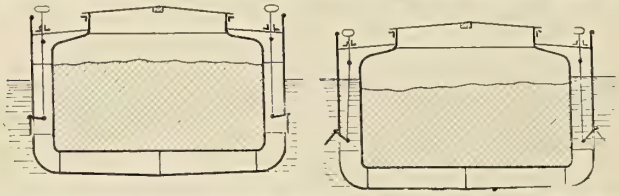
frame, a motor mounted on the bolted end thereof, means for transmitting the power of said motor to propel said wheel, and means for raising and



lowering the propelling wheel carrying beam frame without disturbing the motor power transmitting connections. Ten claims.

860,492. TRANSPORT VESSEL. OTTO MEHRTENS, KIEL, GERMANY, ASSIGNOR TO FRIED. KRUPP AKTIENGESELLSCHAFT, GERMANIAWERFT, KIEL-GAARDEN.

Claim 1.—In a transport vessel, a ballast reservoir of a height approximately equal to the distance between the load and the light draft



line, and having an opening at its bottom to permit the natural flow to and from the reservoir, and means for closing the opening. Four claims.

860,126. SUBMARINE BOAT. JOHN M. CAGE, DENVER, COL., ASSIGNOR OF ONE-HALF TO JAMES C. HARVEY, DENVER.

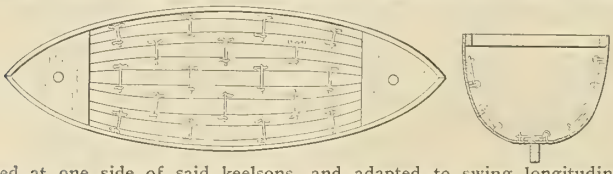
Claim 1.—In a submarine boat, the combination with the normally watertight shell, of centrally pivoted, independently movable, horizontal planes extending longitudinally along its sides, pivoted at the longitudinal center of the boat. Two claims.

860,382. MEANS FOR PREVENTING THE DESTRUCTION OF SHIPS BY SUBMARINE EXPLOSIONS. HOKON HOYOSS, CHICAGO, ILL.

Claim 4.—In a device of the class described means attached to a ship's hull comprising a watertight compartment provided with a plurality of plugs which will automatically be removed by the force of an explosion under water, to provide a vent or outlet for said explosion, and means for indicating the location of said explosion. Five claims.

860,951. LIFE-BOAT. CHARLES W. WEILAND, LONG ISLAND CITY, N. Y.

Claim 1.—A metal life boat provided with detachable keelsons, said keelsons being connected with the hull of the boat by means of arms

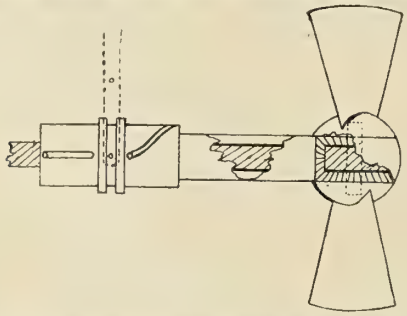


hinged at one side of said keelsons, and adapted to swing longitudinally thereof, and hooks at the opposite sides of said keelsons, and adapted to be engaged by said arms. Two claims.

British patents compiled by Edwards & Co., chartered patent agents and engineers, Chancery Lane Station Chambers, London, W. C.

4,927. SCREW PROPELLERS. H. B. BULLINGHAM, SOUTH KENSINGTON, LONDON, S. W.

A reversible screw propeller is constructed with a boss in the form of a sphere, having no projections except the blades and the shaft. A two-bladed propeller is described, but the invention is not confined thereto. The boss is made in three portions, the central portion being secured to the shaft. The remaining two portions are screwed on to a stud having at each end threads of opposite hand, and prevented from rotating in the boss



by a lug, which fits into one of several slots in the boss. The blades are feathered by bevel wheels cut in a sleeve and the two parts of the boss, the sleevee being rotated by a pin, which slides in the slot. When feathered, the blades are slightly unscrewed from the central portion of the boss.

5480. SPARS. P. TATCHELL, HOLLAND PARK, LONDON.

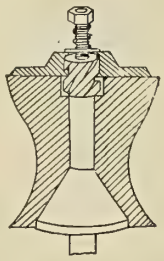
Spars for the booms of sails, the framework of flying-machines, etc., are braced by means of stays which can be adjusted to obtain any required degree of curvature of the spars. A mainsail boom of rectangular, cruciform, or other section, is connected to a mast and provided with struts, the ends of which are forked or notched and may be furnished with runners, over which pass stays, adapted to be tightened by means of tackle or screws, winches, or the like. By slackening one stay and tightening the other, any desired curvature of the boom ma ybe obtained, the slack stay being afterwards tightened in this position of the boom, and the ropes of the tackle fastened to cleats on the deck.

6107. ROTARY PUMPS. A. E. LUTTRELL, BALMAIN, NEW SOUTH WALES, AUSTRALIA.

The pump consists of a cylindrical casing, divided into two compartments by a disk, which is rotated by a belt and pulley. The disk has four or more slots in which slide blades, the sliding motion being produced by circular inclined planes which are formed in one with blocks. Each block and inclined plane occupy one-fourth of the area swept out by the blades. Liquid fills the chamber between two blades, and is carried around and discharged through the block and outlet pipe. By reversal of the direction of rotation of the disk, the inlets may be used as outlets, and vice versa.

5423. CAPSTANS; WINCHES. C. TUCKFIELD AND W. G. DE F. GARLAND, EAST MOLESEY.

Motor-driven capstans or winches such as are employed in fishing vessels or for loading coal at sea are provided with a friction clutch in which the members are forced together by screw-and-nut mechanism according to the tension of the hauling rope, and which relieves this tension, when it exceeds a certain maximum, without pulling up the driving engine. The winding barrel is mounted on the driven spindle between



a conical collar and a clutch member, preferably formed with an annular grooved face. The clutch member is mounted on a fast thread formed on the spindle, and the slipping strain is regulated by a spring arranged to bear on one face of the clutch member and adjusted by a screw and nut.

6163. STEERING-ENGINES. DAVIS & CO. AND J. L. BOOTHMAN, OULTON BROAD, NEAR LOWESTOFT, SUFFOLK.

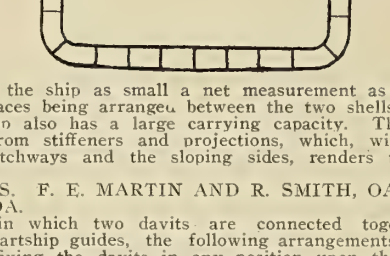
This relates to an improvement in which a steam-actuated stop valve is fitted in the steam passage leading to the controlling valve. Instead of the valve being arranged so that the amount of its opening depends upon the distance of the rudder from its mid-position, it is provided with a cataract cylinder to insure that the valve opens gradually. The spindle carries a cylinder containing glycerine, which receives the hollow plug attached to the cross-head. This plug has an aperture controlled by another spindle. When the valve is opened, the glycerine is forced through the aperture and returns to the cylinder through holes and an annular space provided for the purpose.

6276. SHIPS' WIND SHIELDS. C. VON HELMOLT, BREMEN, GERMANY.

Detachable wind screens for ships are formed of transverse walls of wood, canvas, etc., secured between the decks. If the walls are formed of canvas sheets, these may be stretched by means of ropes between eyes, cleats, or the like, secured to the deck girders and the deck. The walls may be formed with openings or windows, and provided with shelves.

6679. SHIPS. KRUPP AKTIENGESELLSCHAFT, GERMANIAWERFT, KIEL-GAARDEN, GERMANY.

Compartments, hulls, and tanks; ballasting ships; colliers; grain-carrying vessels.—The hull of the vessel is made of a double shell, which extends right up to the main deck and with a continuous seaworthy superstructure, the side walls of which are inclined to the horizontal to correspond approximately to the gradient of the cargo, for the purpose



of obtaining for the ship as small a net measurement as possible, owing to the ballast spaces being arranged between the two shells. By this construction the ship also has a large carrying capacity. The walls of the hold are free from stiffeners and projections, which, with the arrangement of the hatchways and the sloping sides, renders the vessel self-trimming.

6837. DAVITS. F. E. MARTIN AND R. SMITH, OAKVILLE, ONTARIO, CANADA.

In apparatus in which two davits are connected together and are movable on athwartship guides, the following arrangements are employed: (1) means for fixing the davits in any position upon their guides; (2) specially arranged rollers for carrying the davits; (3) winding gear with the shaft in sections connected by a universal joint; (4) brake gear for the winding shaft; (5) mechanically operated chocks; (6) automatically disengaging rigid grips.

Errata.

In the September number of this magazine two serious errors occur. On page 371 is a cut of the boiler of the French steamer *La Rance*. This, through some mischance, was placed up-side-down, and the error was not discovered until the magazine had been bound. The other error occurs on page 375, where it is stated that the first of the light vessels, there described, was built by Harlan & Hollingsworth, Wilmington, Delaware. This vessel was, in fact, built by the New York Shipbuilding Company of Camden, N. J.